~~Now the [illegible] bands in fury passed~~

Confusion seized the ~~[illegible]~~

p

This dire mishap

~~Th~~

This [illegible]

Confusion seized his

a ~~[illegible]~~

Confusion in him

~~This~~

a Mournful [illegible] his a

The rugged steep of all its glories shorn ×
~~[illegible]~~ his peoples eyes a sight forlorn
~~[illegible] heart~~
gleamed
~~[illegible]~~

warlike ~~thing~~.

Confusion seized his squadrons bold

broke
Their treacherous foe soon a quick retreat,

he
~~And [illegible] the~~ Rh
ce tate
and bears the ~~Spoils~~ of

no can they now the fight

score
Their treacherous host ~~on~~ that [illegible]

~~[illegible]~~
But quick as they th a safe retreat th
a refuge safe [illegible] from [illegible] a refuge safe
Amongst his friends a ~~[illegible]~~
and [illegible] b
Who greet him now with joyful [illegible]
[illegible]

tout
The valiant prince of lands bereft
~~[illegible]~~
~~[illegible]~~ with flagging steps ~~the battle~~
with flagging pace. their valiant army left

And seek a solace for his wounded pri
This from all [illegible] his [illegible]

Fierce Snowball

[illegible] cries

Oh

This was mishap. a
a

His friend far above Seem the Mountain.
[illegible] ~~Others retreat the~~ hollow
~~The [illegible]~~
~~[illegible]~~ [illegible]

~~Had [illegible] for [illegible]~~ [illegible]
But quick retreat with baffled rage & pain.

~~The [illegible] [illegible]~~ scatter on every side ~~[illegible] stand~~
~~Pressed by the~~ [illegible]
Thy fly
~~[illegible]~~ pass
with fierce assaults

A
GENERAL SYSTEM
OF
CHEMICAL KNOWLEDGE,

&c. &c.

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A
GENERAL SYSTEM
OF
CHEMICAL KNOWLEDGE;
AND ITS
APPLICATION
TO THE
PHENOMENA OF NATURE AND ART.

BY A. F. FOURCROY,
Of the National Institute of France, Counsellor of State, Professor
of Chemistry at various Public Establishments, Member
of many Academies, &c.

IN ELEVEN VOLUMES.
TOGETHER WITH A SET OF SYNOPTIC TABLES IN LARGE FOLIO.

TRANSLATED FROM THE ORIGINAL FRENCH,
BY WILLIAM NICHOLSON.

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A

SYSTEM

OF

CHEMICAL KNOWLEDGE.

EIGHTH SECTION.

Of the Animal Subſtances.

FIRST ORDER OF FACTS.

Generalities reſpecting the Structure and the Compoſition of the Animal Subſtances.

ARTICLE I.

Of the Structure of Animals.

1. AS I have conſtantly proceeded in the examination of the chemical properties of natural bodies from the moſt ſimple to the more compounded, it is neceſſary that I ſhould place the animal matters after the vegetable, becauſe they are of a more complicated order of compoſition. Accordingly their analyſis being more difficult, is leſs advanced, and the reſults that are drawn from them are leſs numerous and leſs certain.

Whatever differences are obſerved between theſe two claſſes of objects, there exiſts, however, infinitely more relations between the animal and the vegetable ſubſtances than between the latter and the foſſil matters that have been treated of before them; on account of theſe analogies the animal matters ſhall here be conſidered in the ſame manner as the vegetable, though with fewer details, as their hiſtory is leſs complete. I ſhall comprehend all that appertains to their chemical properties under four orders of facts.

The firſt ſhall preſent what is requiſite to be known concerning their ſtructure and their general properties both as living bodies and as particular compounds, in order to render the expoſition of their chemical properties ſufficiently intelligible.

In the ſecond order of facts I ſhall exhibit the whole of their general chemical characters or the ſeries of their diſtinctive properties diſcovered by chemical inſtruments.

The third order of facts ſhall be devoted to the hiſtory of the chemical properties of each particular animal matter.

Laſtly, I ſhall refer to the fourth order of facts which will terminate this ſection, the applications of the chemical properties, both general and particular to the exerciſe of their functions, and to the baſes of phyſiology or animal phyſics.

2. The firſt fact, which, as one of the moſt remarkable, ſtrikes in the moſt forcible manner the mind of every obſerver who compares the animals with the other natural bodies, is their exiſtence as ſubordinate to that of the vegetables. There is no one who does not conceive that without the plants no animals could exiſt, and that it is from them that they derive the nouriſhment which the mineral ſubſtances cannot afford them. Thus the vegetables, conſidered with reſpect to the rank which they occupy in the ſcale of beings, and to the relations which exiſt between them and the other productions of Nature, are placed in the middle between the foſſils and the animals. They borrow elements from the firſt, they combine them three and three by the power of vegetation; they prepare by the aid of this combination the alimentary matter for animals, they draw from the boſom of the earth ſubſtances which they bring to its ſurface, and which they aſſimilate in ſuch a manner as to render them proper for the ſupport of animal life: they can exiſt without the animals, but theſe cannot exiſt without them, and if they are not poſterior to them in their formation, they can only be their contemporaries.

3. It follows from this conſideration, that as the true problem of the nature of the vegetable ſubſtances compared with the mineral matters conſiſts in the formation of the former at the expenſe of the latter by the vegetative

power, that of the knowledge of animal ſubſtances compared with the vegetable muſt be comprehended in the inveſtigation of the converſion of the latter into the former. An animal of a given weight grows in a proportion alſo given, and in all its organs at the ſame time. The augmentation of bulk which it experiences can proceed only from the vegetable matter which it adds to its original weight. This ſingle fact well aſcertained proves inconteſtibly that the vegetable ſubſtances is converted into its own body, and becomes animal ſubſtance by a power innate in the body of this animal, a power which is termed *animalization*; and it ſhows at the ſame time that it is by diſcovering the laws, the phenomena, and the cauſes of this converſion, that we ſhall be able to acquire a knowledge of the nature of the materials which compoſe its body.

4. In order to acquire this knowledge, ſo very difficult to be obtained, and with reſpect to which we have hitherto only a few data, it is ſufficiently evident that it is indiſpenſably neceſſary we ſhould firſt know how the animals are conſtituted, or organized, eſpecially in compariſon with the vegetables, and this is what I here term their ſtructure. Rapid and general notions upon this ſubject will be ſufficient for our inquiries. Naturaliſts define animals as living organized beings, which change their ſituation, move themſelves, tranſport themſeves through ſpace, and are endowed with ſenſibility:

bility: they diſtinguiſh them ſufficiently from vegetables by the two latter properties; but this very looſe diſtinction does not fulfil the purpoſe that is to be attained. A number of other ſtill more ſtriking characters alſo diſtinguiſh animals from the vegetables; the external and internal forms differ much in theſe two claſſes of organized bodies. A ſlight ſketch of theſe characters muſt precede and illuſtrate the ſtudy of their chemical properties, as has been done with reſpect to the vegetables.

5. The body of animals reſembles that of vegetables only in a very few ſpecies. We find it divided into different regions or parts of a very different ſtructure, eſpecially in the beſt organized and moſt perfect animals. Of theſe, are particularly diſtinguiſhed the head, the trunk, and the extremities.

The firſt, including in the cranium the important organ of the brain, and the origin of the nerves, bearing outwardly the principal organs of the ſenſes, eſtabliſhes a direct communication and re-action with all the external objects by the eyes, the ears, and the noſtrils. The cavity of the mouth, which is placed in it, conducts to the organs of digeſtion and of reſpiration, and begins each of theſe functions.

The trunk compoſed of vertebræ ſupports a firſt oſſeous muſcular and membranous cavity, in which are lodged the heart and the large veſſels, the lungs, and the trachea; another cavity provided only with muſcles and membranes in front, in which are diſpoſed under the diaphragm, which ſeparates it from the thorax, the viſcera of digeſtion, the ſtomach, the inteſtines, the pancreas, the ſpleen, and the liver, the internal organs of generation diſtributed differently in two individuals which form the ſexes in the greater number of animals, and alſo thoſe which ſecrete the urine.

The limbs or extremities, the one ſuperior or anterior, the other inferior or poſterior, formed of bones in their centre, of muſcles which cover and move them one upon the other like levers, terminated at their extremity the moſt remote from the trunk by diviſions more or leſs regular, ſerve the animals for ſeizing or repelling bodies, for removing them from, or bringing them nearer to them, and for bringing them into the medium which they inhabit.

6. Theſe three grand parts of the body of animals, the head, the trunk, and the extremities though very different in their uſes and apparent ſtructure, are, however, formed of fibres and laminæ which conſtitute textures or kinds of organs which are found throughout. Theſe organs, the firſt foundations of the animal body are the bones, the blood, and lymphatic veſſels, the glands and the nerves.

The bones are the ſolid parts which determine the form of the body to which they give extent and ſolidity. They are connected with each other by ſolid membranes which are termed *ligaments*; their articular ſurfaces are covered with a white layer, leſs hard than themſelves, compreſſible and poliſhed, called *cartilage*, and moiſtened in their articulations with an unctuous liquid called *ſynovia.*

Over the bones are applied bundles of fibres, united into larger bundles, deſtined to cauſe the bones to roll one upon the other, and which are called *muſcles;* they have at their extremities white cords, which effect their attachment or inſertion into the bones, and are termed *tendons;* they are outwardly ſurrounded, and held together by hard elaſtic membranes, with brilliant fibres, which are called *aponeuroſes.* The muſcles are the organs of motion, and give the external form, the toroſity, the roundneſs, the projections, and the depreſſions of the ſurface.

Tubes or ſtrong membranous veſſels, proceeding from the cavities of the upper part of the heart, ramified and extended from thence throughout the whole body, conveying the blood which dilates them, and cauſes them to beat, and theſe are known by the name of *arteries.* At their extreme terminations they open into other tubes or veſſels, which are leſs dilated, leſs elaſtic, and leſs reſiſting, which take up the blood, and carry it from the ramifications to the branches, and to the trunks in the cavities of the baſe in the heart; theſe are the *veins.* Theſe two orders of canals form together the whole of the blood veſſels.

Under the ſkin and between the muſcles, another order of veſſels, thin, tranſparent, tortuous, contracted in different places by interior folds, filled with a white and tranſparent liquid, abſorb and ſuck in this liquid from every part, unite and ſeparate innumerable times, and all paſs into the abdomen, behind the inteſtines and the ſtomach, whither they carry the liquid, which there flows into one, two, or three trunks, which aſcend into the thorax, and open into a vein ſituated near to the heart, where the liquid called *lymph* is mixed with the venous blood; theſe veſſels are called abſorbents, or lymphatics; they are diſtinguiſhed into the ſuperficial and the deep; they are very much varied in their ſtructure, and innumerable in their maſs. The chyle, the product of digeſtion, is mixed with the lymph which they contain in the abdomen, and is poured with it into the venous blood near the heart. The order of abſorbent veſſels, which immediately draw in the chyle in the inteſtines, are particularly diſtinguiſhed by the name of *lacteal veſſels.*

In many regions of the body of animals we find bundles of blood veſſels, contorted in all directions, and having different forms, connected and preſſed together by very fine membranes, which are termed *cellular texture.* Theſe veſſels thus balled together, interlaced very cloſe to each other, and forming a kind of grains cloſely united with one another, very various in their volume, are terminated, beſides the veins which receive the blood again from them, by canals more or leſs wide, by reſervoirs more or leſs ample, which pour into different regions, particular fluids. Theſe circumſcribed collections of veſſels are called *conglomerate* glands. In this claſs or rank, the brain, the lachrymal glands, which prepare the tears, the parotids, the maxillary, and the ſublingual glands which ſecrete the ſaliva, the thyroid, placed under the larynx, the uſe of which is not known, the glands of the mammæ, which prepare the milk, the pancreas, forming the pancreatic juice poured into the firſt of the inteſtines, the liver, in which the bile is prepared, which flows together with the preceding fluid, the kidneys in which the urine is ſecreted, and the teſticles, the ſource of the ſemen. The abſorbent veſſels united into ſmaller intertextures, conſtitute almoſt every where, but eſpecially along the large blood-veſſels of the neck, of the thorax, and of the extremities, at the axillæ, &c. *conglobate* glans, ſo called, becauſe they are frequently rounded into a kind of globules.

From the baſe of the cerebrum, the cerebellum, the medulla oblongata, and the ſpinal marrow, organs placed in the cranium and the vertebral canal, proceed white cords, which paſs out through holes, or fiſſures, and ſpread themſelves, dividing into branches, into ramifications, and into filaments, more and more minute, into all the other parts with the arteries, the veins, and the abſorbent veſſels. They eſtabliſh a communication with the ſeat of the ſenſations and ideas, and ſerve to form or modify both, as well as to convey the cauſe of motion according to the impreſſions made upon the organs of the ſenſes.

All theſe textures are glued together, though diſtinct and eaſily ſeparable, by a ſeries of very fine, and very tranſparent, flat lamellæ, forming between themſelves a multitude of continuous and communicating cells, on which account the whole has been called the *cellular texture.* This texture retains all the parts in their reſpective places; it is looſe and ſuſceptible of diſtention: it is this which unites the muſcular fibres into faſciæ, the different veſſels into bundles. It ſupports ſuch a great quantity of abſorbent veſſels upon its lamellæ, that modern anatomiſts believe it to be intirely formed of them. As it is always lucidated with a gluey and mucilaginous liquor, it has alſo been called mucous texture. We may repreſent it as a ſponge of the ſame form as the animal body, and into the cavities of which all the organs are as it were ſtuffed. The fat is depoſited in its cells.

7. Beſides theſe firſt organic elements, or general textures, which extend throughout the whole body of animals, which enter into the formation of the different regions of this body, we muſt alſo diſtinguiſh; 1. An organ, named ſometimes *lungs*, ſometimes *branchiæ*, ſometimes

times *trachea*, and which is deſtined to eſtabliſh a communication, an uninterrupted contact between the blood, or other different humours of animals and the air, or the aërated water which they inhale; 2. A ſyſtem of organs continued between two orifices, frequently placed at the two oppoſite extremities of the body, which receives, divides, diſſolves, digeſts the aliments, and which repreſents in general a canal alternately dilated and contracted, provided with inſtruments and liquids, deſtined for bruiſing or diſſolving the alimentary ſubſtances, to which canal are attached conglomerate glands, which pour into it diſſolvent juices, eſpecially the liver and the pancreas; 3. A third ſyſtem of organs deſtined to perpetuate the ſpecies by generation, partly concealed in the interior of the body, partly ſituated or projecting outwardly, divided frequently into two ſexes, the union of which, urged by inſtinct, is neceſſary for the re-production of the individuals. The one of theſe ſyſtems appears to contain the individual ready formed, but void of life; this is the female organ, or the agent of the feminine ſex; the other, or the male organ, furniſhes an exciting vivifying liquid, which communicates motion and life to the germ; 4. A fourth ſyſtem which terminates, envelops, and contains all the others under the form of *teguments*, which cover the body, and which is in immediate contact with the water, or the air in which the animals live.

8. Each of the claſſes of organs, of which I have ſpoken, conſtitutes a particular ſyſtem, having a ſtructure, characters, uſes, and nature, different from thoſe of the other ſyſtems, actuated by a motion, an appetite, a manner, a ſenſibility, an activity, an aſpect, we might even ſay a life, which is peculiar to it. Thus we have to diſtinguiſh in the anatomical contexture of animals, the oſſeous, or ſolid *ſupporting* ſyſtem, the muſcular *irritable* ſyſtem, the ſanguiferous *circulating* ſyſtem, the lymphatic *abſorbent* ſyſtem, the glandular *ſecreting* ſyſtem, the nervous *ſentient* ſyſtem, the cellular *communicating* and *connecting* ſyſtem, the pulmonary *heating*, *ſanguiſying* ſyſtem, the alimentary, or digeſtive *aſſimilating* ſyſtem, the genital *perpetuating* ſyſtem, and the cutaneous *perſpiring* ſyſtem. Each of theſe ſyſtems is connected with the others, and it is from their agreement, their aſſociation, their concord, their ſimultaneous and proportional action, that the affection of the animal economy reſults. The more of theſe ſyſtems are united in animals the more perfect they are. Man, who has them all, and in a regular and juſt proportion, is greatly ſuperior to all the other animals. The diverſities of force and energy, varied in the different ſyſtems, and their action, conſtitute the different temperatures in the ſame ſpecies.

9. On the variation of relations of ſymmetry, of number, of proportion between theſe ſyſtems, are founded the differences which exiſt between the animals and the claſſifications

which have been made amongſt them; beginning with man, and deſcending through degrees of organic degradation, more or leſs perceptible, down to the inſects, the worms, and the zoophytes, in which many of theſe ſyſtems are either wanting or defective, for the more the anatomy of the animals advances, the more we find that the differences between them conſiſt rather in the little harmony between the ſyſtems of the organs which conſtitute them, than in the want or total abſence of theſe ſyſtems, as was at firſt believed. Ariſtotle firſt perceived, and this beautiful reſult has ſince been confirmed by innumerable anatomical obſervations, that the differences of theſe internal ſyſtems in the body of animals, were in ſome degree indicated by great differences in their apparent organs, or in the external parts; that this ſtriking diſparity followed and announced, eſpecially in the extremes, the difference of the moſt important ſyſtems, thoſe of the ſtomach, of the organs of reſpiration, of the brain, and of the nerves. The ſkin, naked, or covered with hair, with wool, provided with feathers, covered with ſcales, with a ſhell, the extremities more or leſs diſſimilar, long, ſhort, defective, or more or leſs divided; the fingers, more or leſs numerous or divided; the ſpinal column terminated below by the anus, formed of a greater or leſs number of pieces or vertebræ, prolonged into a tail more or leſs long, the face vertical or oblique, more or leſs oblong; the jaws more or leſs prominent, and conſequently the noſtrils, the mouth, and the tongue, more or leſs elongated; the cranium more or leſs ſmall, the forehead more or leſs projecting, with or without oſſeous appendages or horns; the occipital foramen, placed more or leſs behind, and in a line more or leſs approaching to the horizontal or vertical; the jaws, deprived of teeth, or having only few, or only certain claſſes, or only one of their parts;—theſe are the moſt remarkable differences, and moſt important characters which have been employed for diſtinguiſhing and deſcribing the animals from their diviſion into claſſes, to the ſeparation of genera.

10. According to this varied ſtructure, beginning with the moſt ſtriking differences, taken from the heart, with two, or with one interior cavity, with red or with white blood, circulating either entirely or only in part through the pulmonary organ, from the ſtomach ſingle or multiplied, from the brain and the nerves more or leſs abundant, from the mode of generation, viviparous, or oviparous, and deſcending ſucceſſively to the conſiderations of the body, provided with extremities, four, or only two in number, or deſtitute of theſe extremities, of the varied form of theſe parts, and of their diviſion, of the number, of the ſituation, of the relation, of the teeth, of the organs of maſtication in general, of the ſkin, naked, covered with hairs, with prickles, with ſcales, &c. &c.—All the animals, after man, the chief and

primitive type of organized beings, have been diſtinguiſhed into eight claſſes, namely the mammalia, the birds, the reptiles, the fiſhes, the teſtacea, the inſects, the worms, and the zoophytes. The latter, the moſt degraded in their ſtructure and their functions, fixed to the ſoil upon which they have been produced, reduced almoſt to the condition of the vegetables, to which they approach, and with which they have long been confounded, form the laſt degree in the ſcale of animals. Without entering upon this diviſion and this claſſification, into details foreign to my object, I ſhall content myſelf with obſerving, that all the beings comprehended in theſe ten claſſes, at the head of which man ought to be placed in a particular and diſtinct rank; though he has the moſt ſtriking analogies of ſtructure and of orginization with the mammalia, reſemble each other in the characters of animality, locomobility, the communications inceſſantly kept up with the medium which they inhabit, the prompt and ſudden re-action of the external objects upon their functions, and eſpecially the union of the digeſting, circulating, reſpiring, moving, ſentient, and generating organs. It has been thought, not without ſome foundation, that the immenſe tribes of which theſe ſix claſſes of animals conſiſt, form amongſt themſelves a continued ſeries, an uninterrupted chain of beings, connected by relations more or leſs cloſe, and deſcending, by almoſt inſenſible gradations, from man, the model of animals, down to the polypus, the microſcopic animalcules, and the ſponge. The conſtruction of this chain has much occupied the naturaliſts, eſpecially Bonnet; and if their inveſtigations have not intirely anſwered their wiſhes, they have at leaſt had the advantage of enabling them to compare theſe beings with more accuracy, and to find between them relations which would not otherwiſe have been ſuſpected.

ARTICLE II.

Of the Functions exerciſed by the Organs of Animals.

1. IN the preceding article I have only ſpoken of the general ſtructure of animals, of their parts, and of their organs, in order to point out their differences from the vegetables which they otherwiſe reſemble in ſome general properties. It was a general notion of their anatomy which I wiſhed to give; but this ſuccinct account of their organization, repreſents as yet only the inanimate machine, and as it preſents itſelf to the ſcalpel of the anatomiſt. We ſhould have only a very imperfect idea of theſe beings, if we did not conſider their animated machine, if we did not ſee their parts re-acting

re-acting the one upon the other, and actuated by the motion which the living force communicates to them. In preſenting a ſketch of the exerciſe of this force, in a narrow compaſs, I have no other intention than to aſcertain the real characters with which animals are endowed, inſtead of proceeding blindfold in the examination of their chemical properties, which are to occupy this ſection.

2. The animal coming out of an egg, or the womb of its mother, after having received, by the fecundation of its germ, the motion which animates it, and after having experienced in its membranes, either during incubation or in the uterus, the firſt developments which mark out its traits, and determine its ſpecies, and even variety, fulfils a deſtiny which all mankind obſerve in the living beings. To be born, to increaſe in bulk, to acquire its full growth, to remain for ſome time in this perfect ſtate, to re-produce beings reſembling itſelf, afterwards to decline, and gradually to loſe a part of its forms, its powers and its ſtrength, laſtly to periſh in conſequence even of the efforts which have ſupported its exiſtence:—this is the circle which Nature has marked out for it, and which comprehends the duration as well as the principal events of its life. She has placed in it a power, which cauſes it to deſire, to take and digeſt its nouriſhment, ſoon to aſſimilate it with its own ſubſtance, to augment the maſs of its body, to repair its waſte, to carry the ſuperfluous

fluous parts into certain reſervoirs, and eſpecially into thoſe which ſerve for the purpoſes of generation, and to reject a ſuperabundant or unaſſimilable portion by canals deſtined for this uſe.

3. This principal effect of life ſuppoſes a diſcernment, an appetite, a judgment, which require an immediate communication between the body of the animal and all the beings which ſurround it; ſo that it can reject, remove from itſelf, take, or approach to itſelf thoſe beings, accordingly as they are beneficial or hurtful to it. In this exerciſe of its life, all the organs which conſtitute the animal, all the ſyſtems which form the totality of its texture, act ſimultaneouſly, with order, with conſiſtency, with regularity, and each fulfils a particular function. The aſſemblage and deſcription of theſe functions compoſe what is named animal phyſics, or phyſiology. Ten functions are reckoned to preſide over life, which may be diſtinguiſhed, eſpecially when it is propoſed to exhibit their ſimple reſult, into four claſſes.

The firſt claſs comprehends the functions which immediately ſupport life, and which were formerly called *vital* functions, becauſe the ceſſation of any of them produces the inſtantaneous death of the individual; theſe are the *central ſenſibility, reſpiration* and *circulation.*

The ſecond claſs comprehends the functions, which immediately ſupport life, or which prolong

long its exiſtence and duration; they have been called *natural* functions; they may be ſtopped for ſome time without life being deſtroyed. Such are *digeſtion*, *ſecretion*, *nutrition*, *oſſification.*

To the third claſs belong the functions which render life animated, re-acting in ſome meaſure upon the ſurrounding bodies, which eſtabliſh direct communications between the living animals and the beings which ſurround them; theſe diſtinguiſh the animal the moſt from the vegetable; they conſtitute its ſuperiority; they are *irritability* and *exterior ſenſibility.*

Finally, I rank in the ſixth claſs the function which communicates life, which perpetuates the ſpecies; this is *generation.* I ſhall preſent a ſketch of the phenomena of each.

4. By *Central ſenſibility* I diſtinguiſh the function of the cerebrum, of the cerebellum, and eſpecially of the medulla oblongata, which ſeems to be the primum mobile of all the others, the perfect integrity of which is indiſpenſable to life, at leaſt in the animals in which theſe important organs are well conſtituted. It has ſuch an influence upon all the functions, that none of them can exiſt unleſs it be in its complete plenitude. Thus in man, in the mammalia and in the birds, a very ſlight preſſure upon theſe organs renders the individual ſoporoſe, paralytic, weakens, alters, or annihilates his external ſenſes; a too ſtrong preſſure, a puncture a little deep, an inciſion, or a wound which penetrates to

the centre of the medulla oblongata, deſtroys life as ſuddenly as lightning. Thus an animal is inſtantaneouſly killed by thruſting a ſmall knife between the firſt vertebræ and the occipital. The cauſe and the mechaniſm of this eminently vital function are entirely unknown, as is almoſt every thing that appertains to the living properties of the medullary pulp of the cerebrum, of the cerebellum, of the medulla oblongata.

5. *Reſpiration* is not a function immediately vital in all claſſes of animals; it has this character only with thoſe in which the blood is obliged to paſs through the reſpiratory organ previous to its being ſent into all the regions of the body, as in man, in the mammalia, and in the birds. With the others in which the blood is not obliged to follow the courſe that has been indicated, at every moment of life, reſpiration may be retarded, interrupted, partial, momentaneous, periodical, or in general irregular. Its purpoſe is to bring the blood, either wholly or in part, at every inſtant, or at certain intervals into contact with the air and aërated water. The lungs in man, in the mammalia, and in the birds, the gills in fiſhes, the tracheæ in the inſects and worms, are the organs of this function. It conſiſts in two alternate motions, the one by which the air is received, or *inſpiration*, the other by which the air is evacuated, or *expiration*; an effect takes place between the air and the blood, which modifies

the latter and renders it adapted for life, and the nature of which chemiſtry, as ſhall be ſeen, teaches us to determine. It contributes to ſupport the circulation, which, in a great number of animals would not take place without it. The diaphragm, the ribs, the muſcles attached to them, exerciſe its motions in the moſt perfect animals, in the birds it is ſtill more energetic on account of the organs acceſſary to the lungs, which, with them, extend into their bones and their feathers. It extracts the air from the water in fiſhes, which cannot live in water that has been boiled.

6. *Circulation* is the motion of the blood from the heart into the arteries, and from theſe into the veins, which carry it back again into the heart. It takes place in animals without interruption. The heart is endowed with a great force for expelling this liquid, which, as it dilates the arteries, cauſes them to pulſate: this firſt order of veſſels poſſeſſes a power of contraction which propels the blood into the laſt ramifications; the veins do not poſſeſs the ſame power; the blood is propelled in them by the ſide which repreſſes it, by the valves which prevent its retrograde motion, by the vacuum which its progreſs produces, by the preſſure of the adjacent parts and eſpecially of the muſcles. This function is two-fold in man, in the mammalia and in the birds; the one is pulmonary, and carries the blood by a ſhort paſſage from the right to the left cavities of the heart; the other, which

is general, carries it from the latter cavities into the whole body, and brings it back to the right ſide: theſe two circulations form together a route, which is pretty well repreſented by the type or figure 8. In the animals placed below the birds, the heart has not the ſame number of cavities, and the blood does not take exactly the ſame courſe; reſpiration is not neceſſary to the integrity and the continuity of its circular motion; the cavities, the canals through which it paſſes, the courſe which it takes, vary, and deſcend, in ſome meaſure through a ſcale of degradation down to the loweſt claſſes of animals. The three inferior claſſes, the teſtacea, the inſects, and the worms, have white cold blood, a heart imperfectly organized, or a dorſal veſſel which ſupplies its place, an irregular and very feeble circulation. The zoophytes, the laſt claſs, have neither heart nor circulation.

7. Digeſtion conſiſts in the introduction of aliments into a canal or ſac in which their nature is changed, they become ſoftened, diſſolve and ſeparate into two ſubſtances; the one, the chyle, which paſſes into the veſſels in order to renovate the blood, and ſerve for nutrition; the other which paſſes out of the body in the form of excrement. This function is very much varied, both with reſpect to its organs and to its reſults, in the different claſſes of animals, and frequently even in different genera of the ſame claſs. We may, however,

diſtinguiſh in it four periods: the firſt, the preparatory, comprehends the bruiſing, maſtication and deglutition; the alimentary bolus is formed and conducted into the ſtomach in this firſt period; the ſecond, which comprehends the digeſtion in the ſtomach, or the change of the alimentary matter into chyle, or homogeneous pulp; the third, which belongs to a ſecond change produced in the inteſtine, and which ſeparates the chylous matter from the excremental; finally, the fourth, which comprehends the abſorption of the chyle that has been formed, by the lacteal veſſels, and the expulſion of the excrement.

Theſe four periods are very diſtinct in man, in the mammalia, the birds, the reptiles, the fiſhes, and the inſects. They preſent in them a multitude of modifications, determined by the form of the organs of manducation, deprived of teeth or provided with teeth of very different kinds, deſtined for bruiſing, tearing, cutting; by that of the ſtomach, ſimple or quadruple, or divided into craws, of the gaſtric juice more or leſs diſſolvent or weak; by the nature and the quantity of the bile and of the pancreatic juice, which form the ſecond digeſtion, and effect the ſeparation of the digeſted aliments into a chylous part and an excrementitious portion; by the very various length of the inteſtinal tube, which in general is ſhort in the carnivorous, and very long and contorted in the frugivorous and granivorous animals;

by the form, the ſize, the texture, the ſecretory force of the pancreas, of the liver, &c.

This function has not the ſame diſtinct periods in ſome inſects, the teſtacea, the worms, and eſpecially the zoophytes. With the latter, it is merely a ſimple paſſage of the aliment into a ſac or a tube, in which a ſuction, equal in all points, is performed.

8. *Secretion* is ſo termed becauſe it is ſuppoſed to ſeparate different humours from the blood. It is performed by the glands; it is in this manner that the ſaliva is ſeparated in the ſalivary glands, the bile in the liver, the urine in the kidneys, the pancreatic juice in the pancreas, the ſynovia in the articular glands, the ſperm in the teſticles, &c. &c. It is, however, not a mere ſeparation, which would preſuppoſe that each of theſe liquids was contained ready formed in the blood; but a real particular change of the latter in each gland, as I ſhall ſhow at the cloſe of this ſection. There is no function in animals which is more general, more extended and more varied than this. It preſents a multitude of particularities in the claſſes, the genera, and even the ſpecies of theſe organized beings, according to the particular wants of the ſpecies. It conſtantly conſiſts in a preparation of the blood before it arrives at the ſecreting organ, in its change and in the ſeparation of the matter ſecreted in the interior of this organ itſelf, and in the exit or ejection of this humour, frequently effected by an excre-

tory duct. This latter circumſtance is owing to the vital action, a kind of irritable motion of the excretory duct, which experiences an orgaſm, a very well marked erection, at the contact or at the mere ſight of the ſtimulant appropriate to it, as the ſaliva which runs and guſhes out of the ſalivary ducts, at the ſight or even at the mere idea of the aliment that excites the appetite, &c.

9. *Nutrition* is the end of digeſtion and aſſimilation. The alimentary matter converted into chyle, poured in this form into the blood, aſſimilated by its mixture with this liquid, vivified by reſpiration and circulation, is carried by the latter into the different organs; it depoſits in each the ſubſtance proper for exactly ſupplying the loſs which it has ſuſtained. It is changed eſpecially into lymph, which being tranſported into every part and into all the cavities, all the cells of the cellular texture, furniſhes there that mucous, plaſtic jelly, diſpoſed for forming the tranſparent and gelatinous laminæ of which moſt of the animal ſubſtances are formed. On this account the lymph has been appointed as its nutritious baſe, and the mucous texture as its ſeat or organ. However, the idea of nutrition muſt be ſtill more generalized, and each muſcular, pulpy, membranous, parenchymatous, oſſeous organ, conſidered as poſſeſſing the property of appropriating to itſelf, in the blood and the lymph which paſſes through and penetrates it, the matter deſtined

for its own repair. In fact, the exceſs of this nutriment is taken up again, with the part of the organ in ſome meaſure worn and melted, by the abſorbent veſſels, which pouring it into the tide of the circulation, renew or tranſport it outwards by tranſpiration. The nutrition is much more active in the firſt periods of the life of the animal, when its organs, which are dilatable and extenſible to a determined degree, grow till they have attained this term. On this account the digeſtive powers are at that period of life more energetic, the appetite keener, and the quantity of aliment required more conſiderable. It is modified in the different claſſes of animals according to their nature, and very ſimple in the laſt.

10. *Oſſification* deſerves to be conſidered as a particular function, on account of the important part which it acts in the phenomena of life; the formation of the bones in the firſt periods of the life of animals has a great influence upon their exiſtence and their ſtrength. Though this is really nothing more than a ſecretion of oſſeous and ſolidifiable matter, in the gelatinous organ, which forms the baſe of the bones, this ſecretion is ſo general, it holds ſuch an important place in the animal economy, that it ought to be conſidered and ſtudied in particular. The bones, after having been membranous in the firſt formation of animals, becomes ſolidified at their centre and in divergent rays in the flat bones; in three points, at their middle

and their two extremities, in the long bones; in the latter the bones remain for ſome time ſeparated from the body of the bone under the name of epiphyſes; they do not glue themſelves together till about a ſixth of the period of life has elapſed. Towards the period of old age, the bones become more brittle, becauſe the proportion of the ſolid ſalt increaſes in them. Theſe organs, the totality of which conſtitutes the ſkeleton, do more than give form, extent, and ſupport to the different parts of the body of animals. They are alſo levers movable upon each other, which cauſe theſe parts to aſſume various ſituations with reſpect to one another, which favour locomotion, which ſerve for the execution of all the motions and the action depending thereon. We might therefore refer oſſification in this point of view to the claſs of functions, which eſtabliſh a communication between the animals, and the bodies which ſurround them.

11. *Irritability* is one of the animal functions which preſent the moſt wonderful circumſtances and phenomena difficult to be comprehended. This name is given to the living power by which the muſcles or the organs, which form the fleſh of animals, contract themſelves, change their dimenſions, approach and move the bones one upon the other. Their contraction or the diminution of their length, and their dilatation in breadth and depth, their change of dimenſion in general, are effected by the aid of a ſtimulus, which is directed by the

will, and which ſeems to proceed from the focus of the central ſenſibility; they are executed by a motion, the cauſe of which is not known. We know that the concurrence of the veſſels and nerves is neceſſary, in order that it may take place in the animals in which the laſt-mentioned organs are found. It is alſo known that by eſtabliſhing between the nerves and the muſcles a communication with the aid of two different metals in contact with each other, we cauſe this motion to be produced at will, and this important phenomenon bears the name of Galvaniſm, becauſe it was diſcovered by Galvani, an Italian phyſician. Finally, all the experiments have ſhown that this function, which exiſts in all animals, is very energetic even in thoſe whoſe fleſh is white, and down to the Zoophytes, in which neither brain nor nerves have been diſcovered. A puncture, a bright light, or a cauſtic, excite contraction when they are placed in contact with the muſcles. It is to this grand property of the fleſhy fibres that all the motions of animals are to be attributed, from that of the heart which acts inceſſantly and without their participation, to that of the ſmalleſt of their muſcles, which they cauſe to act at will.

12. The exterior ſenſibility comprehends all the ſenſes placed in different regions of the bodies of animals, but more particularly in that of the face, where they are almoſt all united in a line very near to the brain. The ſtudy of this function, which preſents the organs and the ſenſa-

tions of the ſight, the ſmell, the taſte, hearing, and touch, is of all the parts of phyſiology, that which preſents to the obſerver the greateſt number of remarkable facts, and the moſt varieties in the ſtructure and relative extent of each of the ſenſations in the different claſſes of animals. Theſe ſenſations are in general perceived by the nervous extremities ſpread out in a tranſparent jelly at the bottom of the eye, into ſhort and pulpy filaments in the internal ear, into flat and long filaments in the noſtrils, into projecting papillæ upon the tongue, and into ſoft and extremely numerous tubercles under the ſkin. The impreſſion made by light, by ſounds, by ſmells, taſtes, ſurfaces, is tranſmitted to the focus of central ſenſibility by the nerves which propagate it to this focus, which is called the *ſenſorium commune*. The ſentiment of pleaſure or pain, which follows this tranſmiſſion, and the compariſon of theſe different, ſucceſſive, multiplied, modified ſenſations, gives riſe to the ideas and produces all the voluntary motions deſtined for the ſupport of the life of the animal, by furniſhing it with the means of removing or avoiding that which is pernicious, and approaching or ſeizing that which is beneficial to it. None of the animals have, in the number and the relations of their ſenſes, and conſequently in that of their ſenſations, the ſame harmony and proportion which conſtitute the perfectionable character of the human ſpecies.

13. Generation, the moſt incomprehenſible and the moſt hidden of the functions of the body of animals, by perpetuating theſe beings, carries into theſe individuals which all proceed from the ſame ſtock, a reſemblance of form, of ſtructure, and of properties which rigorouſly determine the ſpecies. In this function we ſcarcely know the organs by which it is accompliſhed, and the reſult of their mutual action; even the mode of their exerciſe, the cauſe of their effects, the mechaniſm of fecundation, are covered with a veil the moſt obſcure and impenetrable to man. Anatomy and phyſiology have nevertheleſs made numerous and important diſcoveries, and eſtabliſhed ſome general truths concerning this myſtery. They have ſhown that all the animals which exiſt have formed an integrant part of animals ſimilar to thoſe from which they have been ſeparated; that this ſeparation, this detachment of animals from their parents is effected in ſeveral different ways, that in the animals the moſt ſimple and the leaſt complicated in their ſtructure, there are formed, as in the vegetables, buds filled with ſmall animals ſimilar to thoſe from which they proceed, and which detach themſelves at a certain period of growth, or that a fragment of their ſubſtance ſeparated from a firſt adult individual, forms an animal intirely ſimilar to this, like the ſlips in plants; that in others, and thoſe are the moſt numerous, the concurrence of two organs, the one under the name of ovarium,

containing the animal ready formed, but not animated and living, which is the feminine organ; the other containing a liquid capable of exciting by the ſlighteſt contact the motion of life in this embryo, which is the male organ; that thoſe two organs neceſſary for the fecundation and re-production, are ſometimes united in one and the ſame individual in ſuch a manner as to render it either ſufficient for itſelf, or to admit of a double production in each individual, which then is androgynous; that moſt commonly the two organs are ſeparated in two individuals of the ſame ſpecies, which is termed *ſex*, and that they require, for the purpoſe of fecundation, their union or copulation; that this union of the two ſexes is ſolicited by an imperious want, by an appetite more or leſs violent, which has its period in every year; that this appetite does not ſhow itſelf thus except with the power of ſatisfying it, and of engendering when the growth of the animal is completed, or when the animal is perfect; that it appears to ariſe from an exceſs of nouriſhment, of which the organs, which no longer grow, are no longer in want; that on this account it becomes more powerful, much more frequent, and has no longer any regular period when the animals are furniſhed with a very abundant and very ſucculent nutriment; that when the act of fecundation has been performed, the embryo animated by the ſpermatic liquor grows, either in the womb of the female, or out of it; that after a certain determined time it comes out of it, incloſed in a ſhell or membrane in the form of an egg, and that it now requires only a certain temperature in order to be hatched, as in the oviparous animals; that in the ſame manner, in the viviparous animals, the embryo, having become a fetus by fecundation, is developed in a given time, lives in the womb of its mother immerſed in a liquid, and incloſed in different coverings, and that it leaves the womb when it has acquired a certain growth; that when it has once left the egg or the womb, the young animal, in the firſt claſſes of animals, ſtill retains for ſome time a particular ſtructure in the organs of reſpiration and circulation, but gradually loſes this difference, in proportion as it reſpires and nouriſhes itſelf after the manner of its parents; and that finally at the end of its growth, its being is completed and perfected to the period when the neceſſity of producing its like, of communicating the exceſs of life which it enjoys in all its plenitude, is felt with the laſt development of its organs.

ARTICLE III.

Of the Succeſſion and of the Hiſtory of the Diſcoveries in Animal Chemiſtry.

1. HOWEVER rapid the ſketch of the ſtructure, and of the functions of animals, comprehended in the preceding articles, may be, yet it is ſufficient to ſhow the difference which exiſts between them and the vegetables; and though intended only to ſerve as an introduction to the examination of their chemical properties, it is alſo ſufficient to ſhow, that, notwithſtanding the difference which ſubſiſts between theſe two claſſes of beings, there nevertheleſs exiſt between them a greater number of relations and analogies than are remarked between the plants and the minerals. In the inveſtigation of the real differences which ſeparate theſe two orders of organized beings, the labours of chemiſts have not been fewer than thoſe of the anatomiſts, and if the ſucceſs of their experiments has been inferior to that of the deſcription and knowledge of their organs, modern chemiſtry has ſupplied this deficiency, which depended only upon the imperfection and the inaccuracy of the means and inſtruments which ſhe has poſſeſſed only for ſome years paſt. It will

be an inquiry, no leſs curious than uſeful, how this ſcience has arrived at the point of perfection which it has now attained in this kind of analyſis, through what ſtages it has paſſed, and what may ſtill be expected from it, from the light which it has already thrown upon animal phyſics.

2. The ancient chemiſts, occupied in the ſearch of imaginary properties, in moſt of the natural productions, either for the chimera of the opus magnum, or for the treatment of diſeaſes, have given nothing but erroneous notions concerning the animal matter. Their decompoſition by fire was the only method which they followed, and the ſource of theſe errors. Nothing uſeful is to be found before the middle of the ſeventeenth century. Few chemiſts even occupied themſelves with them, either on account of the diſagreeableneſs and fetidity of this analyſis, or on account of its difficulty, or laſtly on account of the ſum of collective knowledge which it required, and the few chemiſts whom it intereſted, in times when all were zealouſly engaged in the examination of the minerals. I divide the hiſtory of animal chemiſtry into eight epochas, each marked by ſome great diſcovery which characterizes it, more than by the time in which each of them can be fixed.

3. The firſt epocha, which dates from the middle of the ſeventeenth to the beginning of the eighteenth century, is remarkable by a kind

of invaſion which chemiſtry made into medicine, by introducing into it its ridiculous theory of the acids and alkalis. It ſucceeded the chimeras of the panaceas, the elixirs of life, and potable gold, which the alchemy of the adepts had before introduced into the practice of the art, which at leaſt was corrected by the beneficial acquiſition of the mercurial and antimonial remedies, of opium, &c. Tachenius, Willis, Vieuſſens, Sylvius, were the moſt celebrated propagators of chemical medicine, founded upon the acids and alkalis. The functions of animals, according to them, were performed by efferveſcences and fermentations; the acid and the alkaline humours mixed and contended together; maladies aroſe from the exceſs of the one or the other, and the therapeutic art combated them with remedies of a contrary nature. The art of healing was for ſome time infected with this error, which was deſtroyed only by the riſe of experimental philoſophy.

4. I attach the ſecond epocha to the efforts which ſome great phyſicians, equally illuſtrious by their knowledge of chemiſtry, were obliged to make in order to deſtroy the abſurd and pernicious aſcendancy which the theory of the acids and alkalis had aſſumed in the art of healing. After the firſt ſucceſſes of experimental philoſophy; after the great revolution effected in the ſciences by a Bacon, a Newton, and a Boyle, Stahl and Boerhaave occupied

themſelves with liberating medicine from the errors which hypothetical chemiſtry had introduced into it. They were obliged even to rate its uſe in the art of healing almoſt as an abſolute nullity, in order to combat the predominant theory; they appeared almoſt to deſpiſe the important labours and firſt outlines of Mayow, Boyle, and Hales, who had borrowed from chemiſtry new means for advancing animal philoſophy, in order to repel the noxious invaſions which it had made in the healing art. Their great influence upon thoſe who taught, ſtudied, and practiſed medicine, had all the ſucceſs which they aimed at; and it was believed that chemiſtry could have no other uſe in medicine than that of furniſhing new remedies, or improved modes of preparing them. This ſecond epocha dates from the commencement of the eighteenth century to nearly a third of its duration. The theory of the acids and alkalis was overturned and ſoon forgotten.

5. The third epocha in the hiſtory of animal chemiſtry, dates from the moment when the operation of the phoſphorus of urine, found accidentally in 1677 by Brandt, diſcovered ſome years afterwards by Kunckel, prepared for a long time excluſively in the laboratory of Godfrey Hanckwitz, at London, for all Europe, was taught at Paris by a foreigner, and deſcribed in 1737 by Hellot, in the Memoirs of the Academy of Sciences. This proceſs, though tedious, difficult, expenſive, and diſguſting,

was the ſignal of the revival of animal chemiſtry, which then was almoſt intirely neglected. Chemiſts began zealouſly to labour upon urine. Margraff found that the *microcoſmic* or *fuſible* ſalt, the phoſphate of ammonia, was the ſource of its phoſphorus; that it did not proceed from marine ſalt, as Stahl had aſſerted; he gave an excellent proceſs for preparing it, by means of the muriate of lead, added to the extract of urine, and which ſerving to decompoſe, without his knowing it, the phoſphate of ſoda, greatly augmented the quantity of phoſphorus obtained: he even found, if not the real difference of theſe two ſalts, yet at leaſt that there were two different ones in urine. Pott, in 1740 Haupt and Scheffer, in 1753, alſo deſcribed the properties of the fuſible ſalts or phoſphates; Haupt even diſtinguiſhed the phoſphate of ſoda by the name of *pearled ſalt.* Rouelle the elder, who commenced his lectures at Paris about this period, not only ſucceeded in making phoſphorus for ſeveral ſucceſſive years, but began to multiply his reſearches and his products upon the animal matters. In glancing over the proceſſes of his courſe of lectures, publiſhed in 1762, we find that he had cauſed this department of knowledge to make much greater progreſs, than it preſents in the works of his predeceſſors, eſpecially in thoſe of Boerhaave.

6. The fourth epocha in this department of chemiſtry, ſtill ſo new and ſo little cultivated, is pretty accurately fixed by the labours of

Rouelle the younger. Educated for a long time in the ſchool of his brother, poſſeſſed of the notions of this learned chemiſt, accuſtomed eſpecially by long practical ſtudies, to make more exact and more preciſe analyſes than had been made before, diſtinguiſhed amongſt all the chemiſts of his time, by his great and valuable ſkill in diſtinguiſhing bodies, and ſeparating them ably from each other; he particularly occupied himſelf with animal chemiſtry, for which he ſeemed to have acquired a peculiar predilection. He publiſhed ſucceſſively in the Journal of Medicine of Paris, from the year 1773 to 1777, numerous and new inquiries concerning the ſalts of the blood, the water of hydropic patients, the human urine, the urine of the cow and the horſe, compared with each other, concerning the ſugar of milk, concerning the blood, concerning the fuſible ſalts, and concerning the urine of the camel. He confirmed the diſcovery, made in Italy by Menghini, of the preſence of iron in the blood. All his analyſes, deſcribed with ability and ſimplicity, given without forced applications to medicine, preſented new truths, which diffuſed a light over ſeveral points of animal philoſophy. The phyſicians availed themſelves of them, as well as of thoſe of Citizen Cadet upon the bile, which he proved to be a ſoap, in the year 1766. Bucquet advanced a little further in the art of analyſing the blood. Poulletier de la Salle announced ſome new facts concerning a concrete and cryſtalline ſubſtance contained in biliary calculi. The wiſe and reſerved progreſs of all theſe labours, recalled the mind to the advantageous uſe of animal chemiſtry, and the aid which it offered to the art of healing. Succeſsful reſearches were then made into the characteriſtic differences between the chemical properties of animal and vegetable ſubſtances. Several animal acids were diſcovered; and the preſence of the phoſphoric acid in ſeveral of the animal humours was aſcertained. In a word, chemiſts became inſpired with new courage, and this kind of analyſes aſſumed a luſtre which it had never exhibited before.

7. The fifth epocha which I diſtinguiſh, is remarkable for three extremely ſtriking diſcoveries relative to the animal analyſes, made in Sweden during the ſame time that belongs to the preceding, but known ſomewhat later in France. In 1772, Scheele, a Swediſh apothecary, and Gahn, doctor of medicine in the ſame country, diſcovered the phoſphoric acid in the bones of animals, the ſolid matter of which they aſcertained to be phoſphate of lime, and deſcribed means for ſeparating from them theſe ſubſtances, which till then they had not even been ſuſpected to contain. Rouelle the younger, Nicolas de Nancy, Berniard, Poulletier de la Salle, and Macquer, confirmed this diſcovery, and added ſeveral important facts, with regard to the comparative nature of the bones of different animals, and the proceſs of their analyſis.

This ſalt has been found amongſt the foſſils, and afterwards the chryſolite was diſcovered to be compoſed of it. Scheele announced, in 1776, that the ſame ſalt, the baſe of the bones, exiſted in the human urine with an exceſs of phoſphoric acid which rendered it ſoluble. In the ſame year, and in the ſame Memoir, the Swediſh chemiſt diſcovered a particular acid in the calculi of the human bladder. It was then, that by comparing theſe three capital diſcoveries with ſeveral facts of phyſiology and pathology, it became generally acknowledged that chemiſtry, treated in this manner, might be applied with great utility to the art of healing, and that ſo far from there being any reaſon to apprehend the errors which had already endangered its fate, on the contrary, its important applications could no longer be diſpenſed with.

8. At the ſame time nearly, and confounding itſelf with the preceding, though deſerving to be diſtinguiſhed by its object and its views, is placed a ſixth epocha, not leſs important than any of thoſe that have been indicated. It is conſtituted by the firſt data which the pneumatic doctrine, ſtill in its infancy, afforded to the chemiſtry of animal matters. Lavoiſier, while operating in the year 1774, upon the analyſis of the air, aſcertained with preciſion the ancient, but vague compariſon which had been made between the reſpiration of animals and combuſtion, and found that it altered the

air after the manner of charcoal. Condorcet then gave the name of vital air to the reſpirable part of the air. Crawford found in reſpiration, and in the air, which is ſubſervient to it, the ſource of the animal heat. Carminati diſcovered that the mephitis, in rendering animals inſenſible, deſtroyed the irritability of the heart and of the muſcles. Lavoiſier was ſucceſſively led to ſtudy, with Citizen Seguin whom he took as the aſſociate of his reſearches, the phenomena and the influence of tranſpiration, and to aſcertain that a great analogy ſubſiſted between this function and reſpiration. Citizen Spallanzani at the ſame time made a kind of living analyſis of the gaſtric juice, and confirmed its diſſolvent quality, which had been already proved in 1743 and 1744 by the ingenious Reaumur; he alſo diſcovered in it a ſtrong antiſeptic power. This new career, which, it is evident, deſerves to form an epocha in the hiſtory of animal chemiſtry, has not ſince been interrupted. It has diffuſed the cleareſt light over the phyſical nature of animals, and proved that phenomena, which are truely chemical and appreciable; take place in the exerciſe of their functions. It is in ſome meaſure a living chemiſtry, which Mayow had a glimpſe more than a century ago, which was purſued in ſome points by Hales at the beginning of the eighteenth, and reſumed in our time by its relations equally eſſential and immediate with the principal phenomena of the pneumatic doctrine which ſtand in ſo natural a connection with it.

9. The ſeventh epocha, which is ſtill more important than the preceding, on account of the greater number of objects diſcovered, or at leaſt illuſtrated, which it includes, and the generality which it embraces, relates intirely to the reſearches of Citizen Berthollet. This illuſtrious chemiſt, after having embraced, in the year 1784, upon the diſcovery of the compoſition of water, for which we are indebted to Lavoiſier and Citizen Monge, the pneumatic theory which appeared to him to be confirmed by this diſcovery, advanced animal chemiſtry a new ſtep forwards, by fixing the nature of ammonia which Scheele had only ſuſpected, and by diſcovering in animal ſubſtances a large quantity of azote. Ammonia being deciſively aſcertained to be a compound of five parts of azote and one of hidrogen. Citizen Berthollet ſhowed how it was formed ſo often by the action of fire, by putrefaction, &c. in animal ſubſtances ſo highly charged with azote. He proved, moreover, that the preſence of the phoſphates, and the abundance of hidrogen amongſt their principles, contributed greatly to this difference. There is eſpecially in this new ſet of data, which we owe to the French chemiſt of whom I ſpeak, and in the epocha which I conſider them to conſtitute, a character by which it ſenſibly differs from the preceding epochas; namely, that this ſeventh epocha pre-

ſents a more general and more complete totality and reſult than the others; that it refers not merely to a ſingle ſubſtance or to ſeveral animal ſubſtances in particular, but to all theſe ſubſtances at once; that this inveſtigation having afforded a knowledge of the whole maſs of animal compounds, thoſe which have followed it have acquired a certainty, preciſion, and ſtability, which they could not have had without it, as will be proved by the expoſition of the eighth and laſt epocha of this hiſtorical ſketch.

10. This eighth and laſt epocha comprehends the combination of the labours already indicated in the ſeventh, and the application, ſince become more immediate and more eaſy, of the analyſes to the phyſical Philoſophy of animals, with the uninterrupted ſucceſs of theſe applications, and the real exiſtence of a new career, proper for explaining the moſt obſcure phenomena of this philoſophy, provided it be conſtantly purſued. It is eſpecially from 1777 and 1788 that this epocha ought to be dated, and it extends to the preſent moment. We find in it new and valuable analyſes of milk and blood by Citizens Deyeux and Parmentier, of the ſynovia and of the humour of veſicatories by Citizen Margueron, of the liver of cartilaginous fiſhes by Citizen Vauquelin, of the human ſperm by the ſame chemiſt, of the ſaliva by Mr. Siebold; the diſcovery of a new animal acid, formed by diſtillation, and called zoonic acid by Citizen Berthollet. I, in particular,

have not ceaſed, in this laſt epocha, to continue, availing myſelf of all the new means afforded by the pneumatic chemiſtry, the ſeries of reſearches which I long ago commenced upon almoſt all the animal ſubſtances, for the moſt part with the aſſiſtance of my friend and pupil Citizen Vauquelin; I have publiſhed a great number conjointly with him; and ſome of them are peculiar to myſelf. A rapid enumeration will be ſufficient to afford an idea of them; the converſion of bodies buried in the earth into a fatty matter, combined at firſt with ammonia, the reſemblance of this fatty matter with ſpermaceti, and with the lamellated and concrete part of biliary calculi; its generality or its abundance in moſt animal ſubſtances, which has induced me to conſider it as one of their moſt conſtant products, and to deſignate it by the name of *adipocire;* the proportion of azotic gas diſengaged by the nitric acid from different animal ſubſtances compared; the exiſtence of this gas in the air-bladders of carps; the preſence of gelatin and ſometimes of bile in the blood; the concreſcibility of the albumen, owing to the fixation of oxigen, and the varieties of this humour, dependant upon the proportion of this principle; the preſence of the phoſphates, and eſpecially of that of lime in many of the animal liquids, in which it was not known before, particularly in milk; the abſence of phoſphoric acid in the urine of infants; the calcareous benzoate which ſupplies the place of the phoſphate of lime in that of the herbivorous mammalia; the analyſis of the tears and of the naſal mucus; their catarrhal thickening by the oxigenated muriatic acid; the analyſis of the inteſtinal calculi of horſes, ſince confirmed by Citizen Bartholdi of Colmar; that of the renal and veſical calculi formed by the carbonate of lime, which admits of the lighteſt and weakeſt acids as lithontriptics; the horns, the hair, the tranſpiration of theſe animals, containing and evacuating the phoſphate of lime; the production of the Pruſſic acid by the diſtillation of the human calculi; the ſame, formed in the treatment of all theſe animal matters by hot nitric acid; the inſtantaneous formation of ammonia in all theſe matters treated by the cauſtic alkalis; that of water, when they are treated in the cold by the concentrated ſulphuric acid; the partial decompoſition of the phoſphate of lime by the acids, the formation of the acidulous phoſphate of lime and not the ſimple and pure diſengagement of the phoſphoric acid: ſo that by the proceſſes hitherto given, we do not by far obtain the whole of the phoſphorus contained in bones; a new analyſis of the calculi of the human bladder, which has proved the preſence of four ſubſtances which were not known to exiſt in them, and which ſingularly vary their nature; namely, of the ammoniaco-magneſian phoſphate, of the combination of uric acid with ammonia, of the oxalate of lime in the mural calculi, and of ſilex, the moſt rare indeed of theſe calculous matters; the aſcertaining the real ſolvents of calculi, and their neceſſary diverſity according to the nature of theſe concretions; a more profound examination of the human urine, and the diſcovery of the ammoniaco-magneſian phoſphate which is formed in it, as alſo of a particular matter which gives to this liquid its characteriſtic properties, and which I call urée; the medicinal action of the oxigenated ſubſtances, ſo much applied to ſince by ſeveral Engliſh Phyſicians; the preparation of fat ſurcharged with this principle, employed at preſent with ſo great ſucceſs by one of my pupils, Citizen Alyon, who has particularly followed up my firſt views relative to this ſubject, and has carried them very far: ſuch are the principal reſearches in which I have been engaged ſince the epocha when my friend Berthollet, by his important diſcoveries, fixed the progreſs of animal chemiſtry, which till then had been uncertain and wavering.

11. Though this is not the place to ſhow how all theſe labours and diſcoveries have influenced the progreſs of Animal Philoſophy and the art of healing, it will be eaſily conceived, from the ſimple and preciſe ſketch which I have juſt preſented, how many uſeful applications muſt have been derived from their reſults, and what great advantages they promiſe to medicine. It is evident that this is the only manner of determining the differences which ſubſiſt be-

tween the different animal ſubſtances, of explaining their formation, and the alterations of which they are ſuſceptible; of furniſhing to Phyſiology what the moſt minute anatomy and the moſt exact and multiplied obſervation of what paſſes in living animals could never afford, as theſe two means are ſo ſoon exhauſted. Moreover, theſe firſt data, already ſo important and ſo uſeful, are the fruits of the labours of only a few men. Unfortunately, the number of labourers is very inconſiderable in proportion to the immenſe reſearches which this part of chemiſtry requires, and the multitude of queſtions to be ſolved which it preſents. Scarce a twentieth part of the chemiſts whom Europe poſſeſſes direct their views to this object. What will it be when, having become more univerſally diffuſed, more familiar, and preceded by all the intereſt which they ought to inſpire, theſe grand reſearches ſhall be multiplied; when hoſpitals appropriated to this uſeful inveſtigation ſhall have aſſumed the activity which their importance claims; when the phyſicians ſhall no longer neglect their opportunities of analyſing the morbific matters, &c.

12. It is then that all the hitherto incoherent parts of the new diſcoveries relative to animal chemiſtry will be approximated and linked together, by relations which yet can only be partly foreſeen and ſuſpected; it is then that a monument will be raiſed for which we are as yet only collecting the firſt materials. Some

perſons,

perſons, indeed have already been too precipitate in making applications of the modern chemiſtry to the art of healing; they have been too haſty in forming from them a medical ſyſtem, either of the nature of diſeaſes, or of the employment of remedies. Whatever zeal theſe firſt attempts may indicate in their authors, they are, however, to be cenſured for an exaggeration equally detrimental to both of theſe ſciences, which they have attempted to connect together by premature approximations. They are not, as formerly, chemiſts properly ſo called, who have ventured upon this enterprize; theſe theoriſts are not thoſe particularly to whom we are indebted for the moſt connected inveſtigations, the moſt numerous experiments, the recent diſcoveries upon the animal matters, who have attempted to form a chemical ſyſtem in medicine. Rouelle the younger never propoſed any thing of this kind; Scheele has only given an account of the particular facts which he diſcovered; Citizen Berthollet to whom we owe ſo many and ſuch ingenious labours in this new province of chemiſtry, has allowed himſelf only to make ſome particular applications of them; and if I may be permitted ſtill to quote myſelf here, after the reſearches relative to this department of the ſcience, in which I have been inceſſantly engaged for nearly twenty years paſt, I have never even attempted to eſtabliſh a general theory. I am thoroughly convinced that the efforts of chemiſtry will hereafter change the aſpect of medicine, that they will produce a happy revolution in this as well as in all the other departments of phyſics: but this period has not yet arrived, and too many deficiencies ſtill remain for theſe changes to be admitted. I ſhall carefully collect, at the end of this ſection, ſuch important applications as the actual ſtate of chemiſtry permits to be made to animal philoſophy, to which I ſhall at the ſame time ſubjoin ſeveral new proſpects, which naturally preſent themſelves: but ſo far from forming a complete ſyſtem, it will be ſeen that they only prove the neceſſity of continuing our inveſtigations and not relinquiſhing a ſeries of inquiries which will hereafter conduct us to the deſired end.

ARTICLE IV.

Of the General Reſults of the Modern Experiments upon the Animal Compounds.

1. THE labours of the modern chemiſts upon animal chemiſtry have not been confined to adding a more or leſs numerous ſeries of new facts or of inſulated diſcoveries to thoſe which had been made before them; they have more eſpecially conducted philoſophers to general reſults reſpecting the nature of the animal compounds.

It

It is even in this circumſtance that the real difference between the epocha of the pneumatic chemiſtry and thoſe which had preceded it conſiſts. Till then the ancient chemical facts preſented neither a general coincidence, nor data that could be applied to all animal matters; they formed truths unconnected with one another; they admitted of none of theſe approximations which really conſtitute the ſcience, and without which it does not exiſt.

2. One of the principal objects of theſe labours has been to examine with attention the analogy announced after Boerhaave between the animal and the vegetable compounds. They have been found to reſemble each other in their complication; they have been conſidered as ſubſtances which, having at firſt been vegetable, have acquired in the bodies of animals, and by their vital powers, a more complicated compoſition. Since that time we have been able to conſider the organs of animals as chemical inſtruments, deſtined for uniting a greater number of principles together than the vegetable inſtruments; provided, however, that they ſhould act upon compounds at leaſt ternary, already previouſly formed in the organic texture of the plants; for obſervations eaſily ſhow that no mineral ſubſtance can be changed immediately into animal matter in the bodies of animals.

3. In order to eſtabliſh this compariſon, which ought, however, to conduct us to the

determination of their differences; after having repreſented the animals as formed, like the vegetables, of immediate principles, in the enumeration of which an extractive matter has been found in the fleſh, &c. a gelatinous mucilage in the membranes and the bones, anſwering to the vegetable gum, a ſugar of milk anſwering to the ſugar of plants, fats repreſenting their fixed oils, reſins, particular acids, and the albumen reſembling the gluten of flour; it was very natural, immediately after the labours of Rouelle, that we proceeded to conſider the animal matters as real immediate materials of vegetables, modified only in ſome of their properties.

4. But without entirely rejecting every part of theſe analogies, it was ſoon found that they ought not to be admitted in too ſtrict a ſenſe; that they exhibit perhaps more differences than reſemblances between theſe two claſſes of bodies when compared with each other; that none of theſe immediate materials could be rigorouſly judged to be of the ſame nature; that the more attentively they were examined, the more diſtinct characters they were found to poſſeſs; that thus the immediate materials of vegetables which paſs into the bodies of animals ſpeedily acquire in them, and by the ſlighteſt exertions of the vital power, properties very different from thoſe which they originally poſſeſſed. Beſides which, the different ſubſtances entering into the formation of the body of ani-

mals were ſubject, as immediate materials, to a more eaſy ſeparation, becauſe they are more inſulated from each other and more diſpoſed to ſeparation, it was alſo found, that ſuch of theſe materials as appeared to be the moſt ſimilar to ſome one of thoſe of the vegetable, nevertheleſs differed from it much more in its intimate nature, and conſequently in the phenomena which is preſented in chemical experiments than had at firſt been imagined.

5. The changeableneſs of the animal matters already verified long ago, announced that their more complicated compoſition was the principal cauſe of it; we began clearly to conceive why they were leſs permanent than the vegetable ſubſtances, why they were decompoſed more eaſily and more ſpeedily, why their changes were more rapid, and why they never remained in the ſame ſtate. The number of their primitive principles being greater, had it been augmented only by a ſingle one more than the three which have been well aſcertained in the vegetable compounds, namely carbon, hidrogen, and oxigen,—the ſingle addition of azote to theſe three firſt conſtituent elements of the vegetable alimentary matter,—an addition produced by the phenomena and the powers of life, is ſufficient to enable modern chemiſts to explain their changeableneſs, by calculating the multiplicity of attractions to which this number of the principles muſt give riſe.

6. This laſt notion, acquired chiefly from the diſcovery of Citizen Berthollet, conducted me to another not leſs general or leſs important, relative to the animal matter; namely, that when deprived of the azote with which its compoſition is complicated, eſpecially by the action of diluted nitric acid, this matter ſeems to experience a retrogradation, and to return to the ſtate of vegetable matter, ſuch as it had been before it had undergone animalization. It is thus that I eaſily account for the abundant converſion of the animal compound into an acid ſimilar to that which is alſo produced by the chemical art in the vegetable matters; an acid which it affords even in greater abundance than the materials of plants do, as Citizen Berthollet had announced ſome years after the diſcovery of the preparation of the acid of ſugar, or the oxalic acid by Bergman.

7. The complication in the compoſition of animal ſubſtances, which is the common ſource of their differences, and at the ſame time of analogies with vegetable ſubſtances, does not conſiſt merely in the addition of azote but alſo in that of ſulphur and of phoſphorus; theſe three combuſtible bodies, combined with carbon and hidrogen, are the common ſource of the fetid gaſes diffuſed by animal compounds during their decompoſition, by whatever agent it may be effected. The tendency which two of them have to aſſume the form of gas, and that which the three others have to

diſſolve together or ſeparately and in very different proportions in the two former, are the cauſes of this fetor, which has always been acknowledged as one of the moſt marked characters of the animal ſubſtances.

8. We muſt alſo reckon amongſt the important reſults afforded by modern chemiſtry, relative to the compoſition of the animal ſubſtances, and their general differences, the preſence of the phoſphates ſo accurately eſtabliſhed by Scheele, by Citizen Berthollet, and by my own inveſtigations concerning thoſe ſubſtances. It will ſoon be ſeen, not only that theſe ſalts form ſometimes nearly the whole texture of ſeveral organs, that they give a more or leſs marked character to ſome of the liquids of animals, but alſo, that they act an important part in the chemical phenomena which both preſent to the obſerver; and that they give riſe to ſome of the principal properties which are diſcovered in them by analyſis. In this abundance of the phoſphates, conſiſts one of the moſt ſtriking differences preſented to the chemiſt by the animal compound compared with the vegetable.

9. Laſtly, we ought to refer to the totality of the modern diſcoveries, and to the new analyſis of animal matters,—we ought to rank amongſt their moſt valuable reſults, the knowledge which they have afforded concerning the proportion, or the relation of quantity, between the conſtituent principles of thoſe matters. Without this knowledge all the reſt would be

barren, it is this which fecundates it by rendering it complete. It has been found that animal matters contain more hidrogen and leſs carbon than the vegetable, more ſulphur and phoſphorus, more phoſphates with different baſes than the vegetable compounds; and that the converſion of the latter into the ſtate of animal compounds does not conſiſt merely in the addition of ſome principles and the complication of their compoſition conſequent upon this addition, but alſo in the change of the proportion of thoſe principles.

10. Thus the general reſult of all the various labours upon the animal analyſis, that which includes all the other particular reſults, which gives riſe to them, and which is their common ſource, ſhows that animal matters are compounds, at leaſt quaternary, formed by the union of hidrogen, of carbon, of azote, and oxigen, with which are frequently aſſociated, in very variable proportions, ſulphur, phoſphorus, lime, magneſia, and ſoda. Theſe compounds, leſs carbonated but more hidrogenated than the vegetable ſubſtances, are brought to the ſtate of oxides by the oxigen they contain. The proportion of hidrogen in them being more conſiderable, the azote being very abundant, the phoſphorus and the ſulphur frequently uniting in them their particular attractions, there reſult from them, matters more or leſs combuſtible, eaſy to be decompoſed, very alterable, very fetid in moſt of their alterations,

very much inclined to aſſume the oily character, and to furniſh ammonia. Theſe are the truths well eſtabliſhed by the new diſcoveries; and all that will follow this general expoſition in the preſent ſection will be only a development or application of theſe doctrines.

SECOND ORDER OF FACTS.

Of the Chemical Properties or Characters of Animal Subſtances in General.

Article I.

Of the General Conſideration of this Order of Facts.

1. IT is not ſufficient to have enunciated in the preceding article the general nature of the animal compounds: to know what they are formed of in general, gives indeed a notion of their difference from vegetables, and of their particular mode of exiſtence; but this notion can only be conſidered as an introduction to their chemical hiſtory, or as a firſt means of arriving at the expoſition of the latter. It conducts us to it without being able to ſupply its want; it may precede it, but it cannot be ſubſtituted in its place. When once well conceived, it leads to the underſtanding of the real chemical properties of animal matters; but alone it will never conſtitute them; it muſt even demand that we ſhould paſs from the general conſideration of this compoſition to the exhibition of the properties of the animal matters.

2. In fact, when we know the nature of the principles which enter into the compoſition of the animal ſubſtances, we may explain the phenomena which they preſent when placed in contact with different other matters; and it is thoſe phenomena, and their manner of comporting themſelves with the different agents by which they are treated, that conſtitute the chemical properties of theſe ſubſtances. There are two methods of conſidering theſe properties: we may either treat of thoſe that belong to the totality of theſe ſubſtances, and are found in all in a more or leſs remarkable degree, or we may occupy ourſelves with theſe properties with relation to individual animal matters; and theſe contain the characters which diſtinguiſh each of them in particular. The firſt conſtitute the object of this ſecond order of facts: the others ſhall be examined in the third order.

3. As to the properties of the firſt kind, or thoſe which belong in general to all animal ſubſtances, only a very ſmall portion was formerly known of thoſe which have been diſcovered within about twelve years paſt; chemiſts occupied themſelves with ſcarcely more than one of the products obtained from them by the action of fire, and the phenomena which their putrefaction exhibited; namely, the production of what was called *volatile ſpirit* and *volatile ſalt*, and which, as we ſhall ſoon ſee, is only carbonate of ammonia by diſtillation. It was only by this character that animal ſubſtances were

then diſtinguiſhed from the vegetable; but ſince the modern diſcoveries there exiſts a much greater number of diſtinctive characters; for the mode of action of moſt bodies upon the animal ſubſtances furniſhes as many characters proper for diſtinguiſhing them.

4. Though theſe general properties may now be very much multiplied, and divided into as many ſpecies as there are bodies that act differently upon the animal matters, it is eaſy to refer them to a certain number of heads, which I reduce into nine articles.

In the firſt, I ſhall treat of the action of caloric upon theſe ſubſtances.

In the ſecond, I ſhall examine that of the air.

In the third, that of water.

The fourth ſhall have for its object the action of the acids.

The fifth, that of the alkalis.

To the ſixth will belong the properties which animal ſubſtances preſent with the ſalts, and the metallic oxides and ſolutions.

To the ſeventh I ſhall refer thoſe which ariſe from the action of the vegetable ſubſtances.

In the eighth I ſhall examine the acidifiable property of animal ſubſtances, and the principal acids which they afford, eſpecially the Pruſſic acid.

Laſtly, the ninth article ſhall be appropriated to the examination of putrefaction.

It muſt be evident that theſe nine titles comprehend the action of all the claſſes, or all the genera of bodies upon the ſubſtances with which I am engaged, and that ſuch a diviſion can leave nothing to be deſired relative to their general and characteriſtic properties.

ARTICLE II.

Of the Properties derived from the Action of Caloric upon Animal Subſtances in general.

1. CALORIC acts upon the animal ſubſtances by decompoſing them more or leſs rapidly, by changing the combination of their principles, by ſeparating from them products which did not exiſt as ſuch in theſe matters. This general action ſo far reſembles that which this agent exerts upon the vegetable ſubſtances; it reſembles it by tending alike to their deſtruction, by inſulating their principles, by uniting them in another order, by deſtroying the homogenous compoſition of which they were formed. But the analogy ſoon diſappears in a great meaſure, when we examine with attention what paſſes in this ingenious decompoſition; the phenomena are extremely different, and the greater complication of effects which take place are adapted to throw the greateſt light

upon the nature of their primitive compoſition itſelf. The diſcoveries to which the attentive obſervation of this phenomenon has given riſe, and the influence which they have had upon our knowledge of the animal matters, are among the moſt happy and moſt uſeful reſults of the modern chemiſtry and the pneumatic doctrine, to which we are indebted for theſe diſcoveries.

2. Though the action of a mild heat, and the introduction of a ſmall quantity of caloric into the animal matters, is in general confined, as with the vegetable matters, to thickening their liquids, giving them the concrete form, drying their ſolids, extracting from the one as well as from the others, a more or leſs conſiderable quantity of water, as it is obtained on the water-bath; yet this action, feeble as it is, preſents very remarkable differences, which become diſtinct characters of animal ſubſtances. A gentle fire tends to coagulate thoſe that are liquid, and this coagulation is accompanied with opacity and a change of nature; this is announced by the change of taſte, and by the inſolubility in water which theſe coagulated matters acquire. The water, which is diſengaged on the water-bath, is in part contained in theſe matters, and in part formed by the action of the fire; it has a particular faint taſte; it contains ſome matters which give it the property of becoming turbid, of depoſiting flakes, and of putrefying much

more ſtrongly and quickly than that which is obtained from the vegetables. The animal ſolids, if heated not very violently, experience a change of colour, of conſiſtence, of tenacity, of ſmell, and of taſte, which is known by the name of *baking*, and proceeds from a commencement of alteration which has not yet been exactly determined.

3. The difference of the action of caloric is much more conſiderable, when we expoſe the animal compounds to a more active fire, and to the contact of combuſtible ſubſtances in the ſtate of inflammation or ignited to redneſs. We ſee theſe ſubſtances become agitated, contorted, and bend themſelves in different directions, ſo as to exhibit a remains of irritability, or mobility, to this decompoſing ſtimulus; we might ſay, that, though dead, they ſtill oppoſe ſome reſiſtance to their deſtruction. When this almoſt convulſive ſtimulus has abated, the ſubſtances thus heated with a naked fire, and in an open apparatus with the contact of the air, become ſoftened, or melted, ſwell, exhale an abundant vapour, or ſmoke, of a white, yellowiſh, or reddiſh colour, which diffuſes a fetid ſmell known to every one, and greatly differing from that perceived in the vegetable matters when treated in the ſame manner. Almoſt always an ardent and lively flame ſucceeds theſe firſt effects, and the reduction into coal or aſhes, more or leſs coloured, which terminates them, leſs ſpeedily and leſs eaſily than happens in the vegetables,

tables, indicates the preſence of an oily ſubſtance, whatever the animal body may originally be which is treated in this manner.

4. When animal compounds are heated in a retort of luted glaſs or porcelain, to which is adapted a receiver, provided with a pneumato-chemical apparatus, we at firſt obtain a more or leſs abundant quantity of water, according to the liquid, ſoft, or viſcous ſtate of theſe compounds. This water ſoon comes over brown and turbid; it contains different ammoniacal ſalts; it is ſoon accompanied with carbonate of ammonia, which diſſolves in it at firſt, and afterwards cryſtallizes upon the neck of the retort and the ſides of the receiver. This ſecond product is ſucceeded by oil, which becomes more coloured and conſiſtant towards the end of the operation; whilſt it paſſes no water is diſengaged, or but very little. The oil is accompanied with carbonate of ammonia, which continues to be ſublimed, and part of which is melted and diſſolved by the very hot oily vapour. At the ſame time gaſes more or leſs abundant are developed, and collected in the bell-glaſſes, which terminate the apparatus: if we cauſe them to paſs through lime water, or the metallic ſolutions, or the oxigenated muriatic acid, they precipitate the firſt in chalk, the ſecond in coloured ſulphurets, and they depoſit drops of oil and coaly powders in the third. When the retort which is employed in this

operation is heated to ſuch a degree as to become ignited at the bottom, we no longer perceive any thing diſengaged, either in the aërial, liquid, or ſolid form; the white vapour which fills the apparatuſes of the receivers diminiſhes and is condenſed, even though the fire be very violent. The fire is then put out, and the veſſels are left to cool; they are afterwards unluted, and the products are examined after they have been ſeparated, either by their different place in the veſſels of the apparatus, or by pouring them into a funnel, where each aſſumes a poſition relative to its ſpecific gravity. Thus are obtained coloured water, concrete volatile ſalt, animal oil, gaſes and coal. Each of theſe products merits a particular examination.

5. The water, as I have already announced, varies in quantity according to the ſtate of the animal matter. It is, however, here ſuppoſed to proceed from a dry matter; for liquids are treated on the water-bath, and coagulated, or inſpiſſated before they are treated in the retort. This water was not contained intire in the animal matter, but a great part of it is formed, as I ſhall ſhow hereafter. Here we ſpeak only of its nature. Its colour, which is red, or yellow, or brown, its fetid ſmell, its acrid taſte, its turbid ſtate, prove ſufficiently that it is not pure water. When it is diſtilled with a double heat, or rectified, though carbonate of ammonia is frequently ſeparated from it, it ge-

nerally paſſes more clear, and even tranſparent. When it is treated with lime, ammonia is diſengaged; with the metallic ſolutions it renders them turbid and precipitates them; with the phoſphoric acid, after the lime, and by ſubmitting it to ſolution, a particular acid liquor is obtained, which Citizen Berthollet has diſcovered to be a new acid, and which he has termed the *zoonic acid*. In a word, we find in it an ammoniacal ſoap which colours it, and ſeveral ammoniacal ſalts which may exiſt to the number of five different ſpecies; namely, muriate of ammonia, and carbonate of ammonia, which we already know; zoonate of ammonia, pruſſiate of ammonia, and ſebate of ammonia, which I ſhall deſcribe elſewhere as particular animal ſalts. Theſe five ſalts are not conſtantly found in the liquid product of the diſtillation of all the animal ſubſtances; but it always contains carbonate of ammonia and ammoniacal ſalt. There are ſome animal matters which, after fermentation, yield ammoniacal acetite, inſtead of carbonate, or at the ſame time with the latter. It is evident that this very complicated product, which was formerly called *volatile animal oil*, and was employed in medicine, was then very little known, and that its ſingular nature was not ſuſpected.

6. The concrete and cryſtallized volatile ſalt, which is obtained of ammoniacal carbonate more or leſs ſoiled by empyreumatic oil. The ammonia is here a product of the fire; it does not

exiſt previous to its action in the greater number of animal ſubſtances. It has already been ſeen that its production has long been conſidered as the principal diſtinctive character of thoſe ſubſtances; but its ſource has only been known ſince the diſcovery of Citizen Berthollet, relative to the nature of this alkali, which is compoſed of five parts of azote, and one of hidrogen. It is evident that it is formed by the immediate union of theſe two principles, at the time when the greater part of the water already formed, leaves free hidrogen, and when a very high temperature augments the attraction of the oxigen for the carbon. Accordingly, there is produced at the ſame time carbonic acid, which ſaturates this volatile alkali. This ammoniacal carbonate is rectified by ſubliming it with a gentle fire. The formation of the three other acids frequently alſo accompanies that of the ammonia, which in part unites with them; and this formation is owing to the combination of three ſimple combuſtible baſes with oxigen, as I ſhall explain elſewhere. Formerly great virtues were attributed to this more or leſs oily carbonate of ammonia; it was believed that it carried off from each animal matter from which it was obtained, ſome principle which gave it particular characters: ſuch was that of the viper, of hartſhorn, &c. At preſent it is known that it is one and the ſame, from whatever matter it has been extracted. We ſhall ſee hereafter, that though all the animal matters equally furniſh this product, they greatly differ from each other with reſpect to the proportion in which they afford it. It is alſo to be remarked, that ſome of the immediate materials of plants, eſpecially the extract, the tanin, the gluten, &c. and ſome entire plants, amongſt which are to be diſtinguiſhed the cruciferous, the papaveraceous plants, the funguſes, the nitrous plants in general, yield carbonate of ammonia in diſtillation, and that this property, which they owe to their containing azote amongſt their principles, was the reaſon why they were called in the ſchool of Rouelle by the not improper name of *animal plants*, though it was not known in this ſchool from what ſource that product proceeded.

7. The oil obtained in the diſtillation of the animal matters was no more contained in theſe matters than the ammonia which is volatilized from them; it is equally a product of the action of caloric upon their principles. It is formed at the time when a large portion of the oxigen of theſe matters, abſorbed by the hidrogen to form the water which paſſes over firſt, leaves in the reſiduum a greater proportion of hidrogen which approaches this reſiduum to the oily ſtate. This oil differs from that which the vegetables, treated in the ſame manner, afford, by its abundance, its thick, concrete ſtate, and its ammoniacal nature; it turns the blue vegetable colours green; it has a fetid and very tenacious ſmell. Dippel, a chemiſt of Berlin,

was the firſt who rectified this oil for medicinal uſe: it has therefore been called by his name. This rectification conſiſts in diſtilling it with a mild heat, not exceeding the temperature of boiling water, and which is ſtill better, from this liquid itſelf introduced into a retort with the oil, as Rouelle has recommended. The rectified animal oil is white, very liquid, very odorous, and very volatile; it is quickly turned yellow and brown by the contact of the air, and the light. Carbon which colours it, is ſeparated from it.

8. The gaſes which are diſengaged from animal matters treated in the retort, which Hales had conſidered to be air, and which induced him to aſſert that this principle was the cauſe of their ſolidity, becauſe at the moment when they eſcape, theſe matters generally loſe their coherence, are mixtures of carbonated hidrogen gas, frequently ſulphurated, and even phoſphorated at the ſame time, and carbonic acid gas. They are very fetid, very combuſtible, and they frequently burn with an oily flame: to theſe is owing the infected odour diffuſed by the animal matters which are burned in the air, or which are diſtilled in ill-cloſed veſſels, as well as when the veſſels in which their products have been received are unluted. When theſe gaſes are kept for a long time under water, it becomes turbid; there is frequently depoſited upon the ſides of the veſſel a carbonous and ſulphureous cruſt, of a blackiſh

brown colour; frequently alſo, we perceive drops of a thick brown oil, precipitated and attached to the glaſs; which proves that theſe gaſes carry off a portion of this body in ſolution. If we make them paſs into lime water, they precipitate it in calcareous carbonate; in a nitric ſolution of lead, they form a blackiſh brown precipitate; when they paſs into oxigenated muriatic acid, carbon is ſeparated and precipitated in the liquor. They have been examined and analized by detonation with oxigen gas in Volta's eudiometer, after the carbonic acid had been ſeparated from them by a cauſtic alkaline ley. It was in this manner that Citizen Berthollet aſcertained their nature.

9. The coal which remains in the retort after the diſtillation of an animal matter, very rarely retains the primitive form of this matter; for it becomes ſoftened, fuſed, and ſwelled by the action of the fire. It is more denſe, more ſolid, and adheres more firmly to the glaſs than that of the vegetable ſubſtances; frequently it even forms one ſubſtance with the retort, ſo that its weight cannot be aſcertained, unleſs the veſſel has been weighed previous to the operation, and weighed again at the termination of the proceſs. Its proportion is in general leſs than that of the vegetable coals; it is rarely or hardly ever inflated or cavernous, at leaſt unleſs an albuminous or ſaponaceous liquid has been diſtilled; in the latter caſe alſo, we frequently find only a coally

layer, which occupies more ſpace in the retort. Sometimes the animal coal is brilliant, of a metallic appearance, and it is then found very analogous to the carburet of iron. Its combuſtibility is in general very ſlight; it muſt be kept at a ſtrong red heat, and agitated for a long time in contact with the air, in order to reduce it into aſhes; it is not ſeen to burn ſenſibly, and become covered with a layer of aſhes, like that of the vegetables. The ſtrong fire neceſſary for its incineration, frequently changes the nature of its reſiduum and volatilizes a part of its ſalts. Soda and muriate of ſoda are diſengaged from it; the phoſphates which it contains are vitrified. Accordingly Citizen Berthollet, in order to analyſe the animal coals, has employed nitrate of pot-aſh, by cauſing them to detonate in veſſels proper for collecting the elaſtic fluid products, and the pulverulent reſidues. I have employed the ſuper-oxigenated muriate of pot-aſh for the ſame purpoſe. This character of incombuſtibility, which ſo eminently diſtinguiſhes the animal coals, proceeds from the little carbon which they contain, the denſity which it preſerves in them, its union with the phoſphates of ſoda and of lime, and the oxides of iron and manganeſe, which invelop and condenſe it.

10. All the effects of fire upon the animal matters, which I have juſt deſcribed, all the products which I have examined, prove that caloric, by changing the nature of theſe matters, and making a complicated analyſis of

them, combines their conſtituent principles in another order, and that finding them more numerous than thoſe of the vegetable ſubſtances, it gives riſe to a greater number of new compounds. Water is formed in them leſs abundantly, oil in larger quantity; ammonia, eſpecially in conſiderable quantity, excluſively belongs to them; the acids which unite with them, all announce, like the ammonia, an abundant ſource of azote. Leſs carbonic acid, and more hidrogen gas than in the products of vegetables, indicate a ſmaller proportion of carbon, and a larger of hidrogen in the animal ſubſtances. The ſulphur and the phoſphorus which modify their gaſes, announce the preſence of theſe two combuſtibles in theſe ſubſtances. This ſeries of the effects of fire, and of the products to which it gives riſe, proceeds, therefore, from the primitive complication of the animal compounds, from the multiplied action of their principles upon one another, and from the more numerous attractions which they reciprocally exert. None of theſe effects of caloric, which are very well adapted for elucidating the nature of theſe compounds, though they were formerly believed to be very obſcure and almoſt inexplicable, is at preſent attended with any real difficulty, and it is one of the fineſt reſults of the pneumatic chemiſtry, to have afforded a clear and eaſily intelligible explanation of them. It has been able to derive great advantage from what had long been only a ſource of errors and of obſtacles to its progreſs.

ARTICLE III.

Of the Properties of Animal Matters treated by the Air.

1. THE properties which the animal matters preſent, when expoſed to the contact of the air, and by the effect of this expoſure itſelf, are leſs general and leſs conſtant than thoſe which are produced in them by the action of fire; they vary much more amongſt themſelves, according to the differently modified nature of theſe matters, than the preceding. In general, thoſe which are ſolid undergo very little alteration, or a very ſlow alteration by the contact of the air; the liquid animal ſubſtances are almoſt excluſively and much more ſenſibly changed by the impreſſion of the air; and it is according to theſe changes that I ſhall here announce the properties of theſe matters, referring them to a certain number of general heads.

2. I find ſix different effects produced by the air upon animal ſubſtances, independant, indeed, of thoſe which it can produce in the living animals; for the general characters of the ſubſtances which I examine are taken more eſpecially in their dead ſtate; the vital motion cauſes them to vary, or renders them complicated, and we muſt firſt determine what takes

place in them without the vital principle which animates them, before we can treat of the phenomena which accompany their living ſtate. Theſe ſix effects refer 1, to the abſorption of oxigen; 2, to the concretion which it produces in them; 3, to the colouration to which it gives riſe; 4, to the ſlow combuſtion which it excites in them; 5, to the alteration which it experiences itſelf; 6, finally, to the decompoſition which they ſuffer by the internal motion which it excites in them. I ſhall recapitulate each of theſe effects in ſucceſſion.

3. Almoſt all the animal liquids have the property of abſorbing the atmoſpherical oxigen gas; thoſe which are viſcid, gluey, or ſaponaceous, poſſeſs it in a pretty high degree. This is proved by leaving them expoſed to the air in inverted jars, ſuffering them to elevate themſelves in theſe veſſels, and afterwards examining the reſidual gas by the endiometrical proceſſes. We find that it contains much azote gas, and that it is ſometimes even reduced to this gas in a pure ſtate, when the expoſure to the air has been long continued. The abſorbed gas remains ſimply condenſed, and particularly combined for ſome time: accordingly, the oxigenated liquids ſwell conſiderably in vacuo or by the action of heat. Gradually the oxigen becomes more ſolidly fixed, combines intimately with them, and changes their nature by oxiding them more than they were before.

4. The concretion of the animal liquids conſequent upon the abſorption of oxigen is eaſy to be obſerved, and leaves no doubt of the exiſtence and reality of this ſecond effect in the white of egg, the ſerum of the blood, the water of hydropic patients, &c. expoſed to the air. We ſee flakes formed in the liquids, remain ſuſpended in them, and become precipitated. By agitating the liquids in the air, they acquire ſuch a diſpoſition to concretion, that a part becomes ſolid. In this manner are formed the factitious membranes known at Cos, more than a thouſand years ago, and deſcribed by Hippocrates. The aërated water produces the ſame effect by its mixture and agitation with theſe liquors. White of egg expoſed to the air, or eggs that have been kept for ſome time, boil and harden much more eaſily than very freſh eggs. This phenomenon is connected with the formation and the regeneration of the epidermis; it explains the *plaſtic powers* of the ancients; it ſubſtitutes a ſimple phyſical fact inſtead of an occult quality; it preſents itſelf in the mechaniſm of nutrition.

5. A thouſand phenomena prove the colouration produced in the animal ſubſtances by the contact of the air and by the ſlow abſorption of oxigen. Even the ſolids are not exempted from this conſtant effect. Bones and ivory become yellow, the ſkin turns brown and black in the air; the blood reddens in it and aſſumes the

brilliant purple colour which characterizes it, whilſt that part of it which is deprived of the contact of the air remains of a dark, and almoſt black colour. The white albuminous and gelatinous liquids become yellow; fats acquire a citron or orange-colour; wax and ſpermaceti become yellow; the colours of the kermes, cochineal, ſeveral worms, and ſome molluſcæ acquire their greateſt luſtre by the contact of the air; the bile, the urine, and the perſpiration acquire a more intenſe colour in the atmoſphere; the white diſcharges from the noſe, the lungs, the urethra, from ulcers, become yellow or green; all the marine animal products become darker-coloured and browner when they are taken out of the water and placed in the air; putrefaction is accompanied, and its periods are marked by many different tinges.

6. The firſt effects which have juſt been enunciated, whilſt they indicate a remarkable attraction between the animal matters and oxigen, ſhow pretty clearly that they repreſent a kind of ſlow combuſtion, which cauſes them to paſs into the ſtate of oxides, and which, in ſome caſes, though indeed rarely, gives them even the character of acids: it is in this manner that the acetous acid is produced in ſeveral ſubſtances expoſed to the air, eſpecially in milk and urine. The diſpoſition to coagulation by the fire, or to ſpontaneous concreſcibility, correſponds with the ſolid and concrete form which

the oils aſſume when they are expoſed to it, and repreſents a real oxidation which has its limits and its termination, at the point when the animal matter which experiences it is ſaturated, and can no more abſorb a larger proportion of oxigen. This analogy with the concreſcibility of the vegetable oils authorizes us to conſider the animal compounds as approaching to the oily character, or very much diſpoſed to aſſume it.

7. The four phenomena that have been enunciated do not take place without the air itſelf undergoing a change, a more or leſs conſiderable alteration. When an animal matter has been for ſome time expoſed to it, we find this air leſs charged with oxigen, more ſaturated with water, containing much carbonic acid, and infected with a diſagreeable ſmell. Theſe four changes correſpond with four kinds of effects produced by the animal ſubſtances; they immediately abſorb a portion of the atmoſpherical oxigen; their hidrogen burns rapidly and forms water; their carbon deſtroys alſo a portion of the oxigen gas, which diſſolves and acidifies it; finally, a portion of the animal matter itſelf, already much altered and corrupted, or at leaſt the ſulphurated, phoſphorated and carbonated hidrogen gaſes which are diſengaged from it, give the air a very marked character of fetidity. Thus, we conceive the cauſe of the infection and of the noxious properties which the air acquires in the chambers

of ſick perſons, in hoſpitals too confined, &c. and perhaps even the manner in which certain fevers, &c. are communicated.

8. In proportion as animal matters abſorb the atmoſpherical oxigen, they become diſpoſed to concrete, become coloured, experience at firſt a ſlow real combuſtion, and at the ſame time pour into the air different principles which change its nature, and thus theſe ſubſtances ſenſibly proceed towards that ſpontaneous decompoſition which tends to deſtroy them, or to reduce them to more ſimple, namely, binary compounds. We ſee them from day to day vary in their conſiſtence, their colour, and their ſmell; fetid effluvia and gaſes are diſengaged from them; their volume is changed, their principles exhale; there is formed in them water, carbonic acid, ammonia, or nitric acid; in a word, they ſuffer an inteſtine motion which deſtroys them, ſeparates a portion of them in the gaſeous form, and leaves a part of their fixed reſiduum in the ſtate of mould. Putrefaction, one of the moſt marked characters of the animal compounds, one of the phenomena that moſt deſerve to be ſtudied with attention, will be deſcribed in one of the ſubſequent articles. I have indicated it here only in order to exhibit the ſeries of the effects of air upon theſe ſubſtances; for the contact of air favours and accelerates it.

9. If we compare the ſix effects here indicated, we find as the reſult, a great alterability in the

animal ſubſtances; we perceive that this reſult reſembles that of the action of fire, that it depends upon the complicated compoſition of theſe ſubſtances, the number of primitive principles which conſtitute them, the multiplied attractions which they exert upon one another, and even the ſlightneſs of the cauſe required in order to bring all theſe attractions into play. We alſo ſee compounds formed in them, as to the greater part of their maſs, of combuſtible bodies, having in the totality of their compoſition, as well as in each of their principles in particular, a great tendency to unite with oxigen, abſorbing it at firſt in their entire ſtate, diſſolving in it afterwards into their elements which become ſeparated, and thus experiencing ſucceſſive changes which gradually conduct them to their total decompoſition. The remarkable difference of the volatility of ſome of theſe principles and the fixity of ſome others, alſo renders this general theory more certain and more eaſy to be conceived. We ſhall find it more and more ſtrengthened and confirmed in the ſubſequent articles.

ARTICLE IV.

Of the Action of Water upon Animal Subſtances, and the Characteriſtic Properties to be derived from this Action.

1. THOUGH we have had frequent opportunities of examining the action of water upon animal ſubſtances; though the experiments upon this action are very numerous, even in domeſtic economy and in many of the arts, we not yet poſſeſs all the knowledge which it might be expected to furniſh reſpecting their nature, nor have all the characters proper for diſtinguiſhing them from the vegetable matters been derived from it. There are, however, ſome which are ſufficiently marked and prominent to eſtabliſh important diſtinctions between theſe two claſſes of beings, and theſe I ſhall at preſent ſhow.

2. Cold water penetrates the moſt ſolid animal matters by mere contact: it ſeparates their fibres and their laminæ or plates; it renders their texture more perceptible by thickening and diſtending it; it tends to ſeparate their faſciæ or their layers, and in this point of view, it is employed by the anatomiſt when he wiſhes to proceed further in the inveſtigation of their ſtructure than the ſcalpel and the moſt careful diſſection

tion can load him. There are ſome animal matters which are always found diluted with water, liquefied by it, and owe to it their ſtate, as well as that mobility which permits their tranſportation into different parts of the bodies of animals. Moſt of the animal liquids are eaſily miſcible with water; and if we except the ſolids, all the animal parts are ſoluble in this liquid.

3. When we cauſe hot and boiling water to act upon animal matters, there are ſeveral which, though inſoluble in this liquid when cold, diſſolve in it eaſily and quickly by means of that activity which the caloric communicates to it. Such are moſt of the white membranous textures which melt in boiling water, and afterwards form jellies with it by cooling, and glues by evaporation; it is on this account that theſe textures are called *gelatinous* in chemiſtry. When we give to the water, by compreſſion in Papin's digeſter which prevents its evaporation, a much higher temperature than that of boiling water, we at laſt ſoften even the bones, and cauſe them to aſſume the gelatinous ſtate. The corneous and cartilaginous textures paſs into this ſtate ſtill more eaſily and quickly.

4. There are ſome animal liquids, analogous to the white of egg, and on that account called *albuminous*, which ſuffer by the action of hot water below 48 degrees of temperature, a coagulation, an induration, and an opacity with which

every one is acquainted. This property, which is oppoſite to the gelatinous ſolubility, announces, in the ſubſtances which are ſuſceptible of it, a very different nature, and it has deſervedly occupied much of the attention of chemiſts and phyſicians. Whilſt the latter have deſcribed it as a particular and living power, which they have called *plaſtic*, the former have diſcovered that it depends upon the oxigenated ſtate of the animal liquids, or at leaſt that it is conſequent to this ſtate; that it is owing, as I have ſhown in the preceding article, to the intimate combination, the fixation of this principle.

5. That effect of hot water upon the inſoluble animal ſolids which is the moſt generally known, is the boiling of meat. Chemiſts, however, have not yet accurately determined the mechaniſm of this effect. It is known that there is produced by it, in the boiled ſubſtances, a diminution of their tenacity, a change of texture, of colour, of taſte and ſmell, which renders them agreeable to the organ of taſte and eaſy of digeſtion. It appears that the coction or boiling conſiſts in a change of proportion and of ſtate in the animal compoſition, the fuſion of the gelatine, the coagulation of the albumen, and a kind of maceration of the fibrous organization, which renders them eaſy to be bruiſed by the teeth, and reduced into a ſoft and ductile paſte by maſtication. This property is very different from the coction which the vegetable

ſubſtances undergo, and the change which the latter ſuffer is very diſtinct and leſs ſenſible to every one. Many vegetable matters may be uſed as food in their crude ſtate, but the civilized part of the human ſpecies cannot eat raw animal ſubſtances.

6. Long maceration in water changes alſo the texture and the nature of animal ſubſtances in a manner ſo different from the effect it produces upon the vegetables, that we muſt thence derive a very deciſive character for eſtabliſhing a well marked difference between thoſe two claſſes of organic compounds. Almoſt all the animal matters, when immerſed in water, become converted into a fatty ſubſtance, analogous to ſpermaceti, which I have already indicated by the name of *adipocire.* Ammonia at the ſame time formed, which is diſſolved, and carbonic acid which exhales. It is known that in like circumſtances the vegetables blacken and become carbonated. This phenomenon, in the animal matters, depends upon their putreſcibility; and it is ſufficient here to mention it, ſince its cauſe and its reſults will be treated in a more explicit manner in the article concerning putrefaction.

7. It is evident from theſe effects of water upon the animal compounds, that the general cauſe which determines their differences from that which the vegetable matter ſuffer, depends upon the more complicated compoſition of thoſe bodies. It is always the ſmaller proportion

tion of carbon and of oxigen, and the larger of hidrogen and azote, which give riſe to the changes that have been mentioned, and the phenomena that have been deſcribed. Theſe changes are more numerous, more varied, and more conſiderable, becauſe they take place in ſubſtances, the conſtituent principles of which are more multiplied, and obey a greater number of attractions at the ſame time; it is becauſe they take place in ſubſtances, the equilibrium of whoſe compoſition, is much more eaſily diſturbed than that which exiſts in the leſs complicated vegetable compounds.

In this ſimple explanation we perceive a coincidence which always obtains, between the conſequences of the action of water and the effects of the other agents that have been ſtudied in the preceding articles. This coincidence will alſo be perceived in all the ſubſequent articles.

ARTICLE V.

Of the Action of the Acids upon Animal Subſtances, conſidered as a Character of theſe Subſtances.

1. THE manner in which the acids act upon the animal ſubſtances, furniſhes chemiſts at preſent alſo with a means of characteriſing theſe compounds and appreciating their nature.

The ſcience has made great progreſs with reſpect to the knowledge of this action ſince the eſtabliſhment of the pneumatic doctrine; and in particular it owes much to the labours of the French chemiſts, eſpecially thoſe of Citizens Berthollet, Vauquelin, and myſelf. There are two principal conſiderations to be preſented relative to the action of the acids; the one belongs to all theſe bodies, and is general amongſt them; the other is relative to each of the acids in particular, and differs according to their peculiar nature. I ſhall follow this two-fold manner of conſidering them.

2. All the ſlightly concentrated acids preſerve animal matters and guard them againſt putrefaction; accordingly, they have always been conſidered as powerful antiſeptics, and they have been placed at the head of theſe medicines. All of them have alſo the property of coagulating and thickening the albuminous liquids, of rapidly diſſolving the gelatinous and membranous organs, of preſerving the fluidity of the liquids of the ſame nature, and of preventing them from concreting by refrigeration, as they are accuſtomed to do when alone; they alſo ſoften and diſſolve, with the aid of heat, the fibrous organs, or thoſe which contain in their texture the matter which is called *fibrine.* This ſolution frequently aſſumes the tremulous and gelatinous form. They diſſolve and in part decompoſe the ſolid animal ſubſtance, and change its phoſphate of lime into acidu-

lous ſalt. Laſtly, all the acids, when left for a long time in contact with moſt of the ſoft membranous, or fibrous animal compounds, alter them in the courſe of time, convert a part of them into ammonia, and are afterwards found more or leſs ſaturated with this alkali.

3. The particular action of each acid is determined by its own peculiar nature; it is in general more powerful and more capable of decompoſing animal matters, in proportion as the acid itſelf is more feeble in its intimate compoſition, and as its radical adheres leſs ſtrongly with the oxigen. There are ſome alſo which, without being ſo eaſily decompoſed, act upon theſe matters merely by their acid power. This action varies beſides according to the ſtate of concentration of each of theſe acids,—according to the quantity of acid placed in contact with the animal matters,—according to the more or leſs ſolid or ſoft ſtate of theſe matters; and laſtly, according to the temperature by means of which we cauſe them to act reciprocally upon one another. Amongſt the different acids which exert an influence more or leſs evident, and conſiderably different upon the animal compounds, we muſt particularly diſtinguiſh the ſulphuric, the nitric, the muriatic, and the oxigenated muriatic acids: they comprehend all that need be conſidered as to this particular action; for the others, and eſpecially the phoſphoric, the acetous, the nitric, the tartarous, and the oxalic, ſingularly reſemble the

muriatic. It muſt not be forgotten that the four firſt, taken in a diluted ſtate, exert only the general actions which have been indicated above.

4. There was formerly obſerved in the manner in which the ſulphuric acid acts upon animal matters, the ſoftening which they expeience, with the more or leſs intenſe colouration they undergo: and it was believed that this effect announced a kind of ſemi-combuſtion beyond which nothing was apprehended: it was compared with the action of fire. Citizen Vauquelin and myſelf, on examining the phenomena of this action, diſcovered that the ancient notion was erroneous, and that there takes place between theſe ſubſtances a ſeries of attractions which change their nature in a very different manner than had been imagined. When we immerſe an animal matter, fleſh, for example, white of egg, or coagulated blood, into concentrated ſulphuric acid, and leave theſe two bodies to act ſpontaneouſly, we firſt ſee the animal matter aſſume ſucceſſively the fawn, the red, the brown, and the black colours, become ſoftened, divided, diſſolved, and form a kind of paſte. The mixture becomes heated; nothing is diſengaged; and on examining it after the action is terminated, we find ſulphuric acid weakened with water, which it did not contain at firſt; the animal matter is reduced to coal, and fatty particles detach themſelves from it. If we analyze the ſulphuric acid, we find it in

part ſaturated with ammonia and ſoda. We therefore find that it has decompoſed the animal ſubſtance, that it has ſeparated from it hidrogen and oxigen, which have united to form the water neceſſary for its ſaturation; that another portion has compoſed ammonia, a third has paſſed into the ſtate of fat, and a fourth into that of a coally reſiduum.

5. When we afterwards dilute the acid with a ſufficient quantity of water, then filtrate it in order to ſeparate the fat and coally matter, and analyze the filtrated liquor, we find in it ſulphate of ammonia, ſulphate of ſoda, ſulphate of lime, and a more or leſs conſiderable quantity of acetous acid, which may be obtained by diſtillation. It is therefore proved, that the ſulphuric acid has decompoſed the ſalts of ſoda and of lime contained in the animal matter, that it has converted it into ammonia, acetous acid, water, fatty matter, and coal. We here find an analogy with its effect upon the vegetable ſubſtances deſcribed in the preceding ſection; with very remarkable differences, the formation of ammonia and of fat, and the production of the ſulphate of ſoda and of lime. It would be ſuperfluous to explain in detail the cauſes of theſe differences, ſince what has hitherto been ſaid ſhows ſufficiently that they ariſe from the azote of the animal matters, the greater proportion of their hidrogen, and the preſence of the phoſphoric ſalts.

6. If inſtead of leaving the ſulphuric acid to act ſpontaneouſly upon the animal matters, we aſſiſt its action by heat, its effect becomes more rapid and more effectual. It is no longer, as in the former caſe, merely the tendency of the acid to become ſaturated with water that effects the decompoſition of theſe ſubſtances, and which brings into play the complicated attractions proper for changing their nature. The principles of the ſulphuric acid themſelves tend to ſeparate; the attraction of the hidrogen and of the carbon of the animal matters for the oxigen of the acid, is augmented by the addition of caloric; a more profound alteration takes place in their nature and compoſition. There is no longer any oily ſubſtance formed, with water ſimply conſtituted for the ſaturation of the acid which no longer retains its character; the animal matter approaches much more to the ultimate term of its decompoſition. Accordingly we ſee an effervefcence ariſe, which is prolonged; carbonic acid gas, ſulphureous acid gas, ſulphurated and carbonated hidrogen gas diſengaged. Much water paſſes in diſtillation; for this experiment ought to be made in a diſtilling apparatus; the acetous acid is deſtroyed; we obtain ſulphate of ammonia, and the quantity of coally reſiduum is leſs than in the firſt caſe.

7. The nitric acid comports itſelf in a very different manner with the animal matters, becauſe it is much leſs powerful and permanent, as

an acid, than the ſulphuric, and eſpecially becauſe it is infinitely more decompoſable and much more oxigenated. It was formerly remarked that it gives to thoſe ſubſtances a lemon-yellow colour, and that it does not reduce them to coal like the preceding. Its mode of acting upon the vegetables, which has been explained in detail, in one of the articles of the ſection relative to them, will here ſerve me to account for that which it exerts upon the animal matters; we ſhall obſerve a more complicated operation; we ſhall remark in it important reſults which the pneumatic doctrine has enabled us to deduce from it. When Bergman made known the formation of the acid of ſugar, or the oxalic, by the nitric acid, Citizen Berthollet found, in 1777, that ſilk, wool, the muſcles, the ſkin, the tendons, and the hair, afforded more of it than ſugar, and that this quantity ſometimes even amounted to more than half of their weight, whereas ſcarcely a fourth could be obtained from the vegetable matters. He diſcovered at the ſame time, and, as we ſee, at a period already remote (now nearly twenty-two years ago), that there was ſeparated an oil, during the formation of the oxalic acid, from the animal matters, and that this oil yielded ammonia in diſtillation. This was already a ſtriking difference obſerved in the action of the nitric acid upon theſe matters.

8. Eight years after this firſt diſcovery, the ſame chemiſt made another ſtill much more im-

portant diſcovery, relative to the action of the nitric acid upon the animal matters. Having ſeen that they yielded by this acid, when rather weak, and almoſt without the addition of heat, a large quantity of azotic gas, he remarked that this property accorded with that of yielding ammonia; that when they had loſt their azote they ſeemed to make a retrograde ſtep toward the vegetable ſtate; that all the ſubſtances which furniſh ammonia exhale alſo azotic gas by the action of the nitric acid; that in this action there was diſengaged, after this gas, carbonic gas and nitrous gas; that the oxalic acid was then formed, and the fatty matter ſeparated; that when the yellow liquor was evaporated in order to obtain the oxalic acid, acid phoſphate of lime remained in the mother water: thus he eſtabliſhed a very eſſential difference between the vegetable and the animal matters. I examined, a ſhort time after this diſcovery, all the circumſtances of the diſengagement of azote from animal matters by the nitric acid; I have proved that this acid was not decompoſed as long as that diſengagement continued, and that it thus belonged to the animal matter; that gelatinous matters afforded leſs of it than the albuminous, and theſe leſs than the fibrous; that the azotic gas thus obtained, had a particular faint odour, analogous to that of animal matters when they begin to become tainted, to that of muriate of ammonia ſublimed, of ammonia decompoſed by the oxigenated muriatic acid, &c.; and that its proportion exactly followed that of the ammonia afforded by each animal matter; that when it had been ſeparated from an animal compound, this was no longer putreſcible as before; that this gas was very deleterious, that it appeared to have an influence upon the production of putrid diſeaſes in men expoſed to its action. Since my firſt aſſertion, ſome have attempted to make a point of medical theory of this object, and its reſult has been deſignated by the name of *ſepton gas,* given to the azotic gas.

9. In 1790, another diſcovery preſented itſelf to me in the courſe of my experiments relative to the action of the nitric acid upon the animal ſubſtances; namely, the formation of the Pruſſic acid, and its diſengagement in vapour, eaſily diſtinguiſhable by its ſtrong ſmell of bitter almonds: as it will be treated of more in detail in one of the ſubſequent articles, I ſpeak of it here, only in order to complete the enumeration of the principal effects of this acid. We ſee that thoſe effects conſiſt in a yellow or red colouration, in the diſengagement of azote in the ſtate of gas, in the formation of the Pruſſic acid, of the oxalic acid, of the carbonic acid, and of a fatty matter. The difference of this action from that of the ſulphuric acid, conſiſt in the ſeparation of azote, the formation of a thicker oil, of leſs water, the abſence of ammonia, the non-precipitation of carbon, the formation of the oxalic acid; it

depends evidently upon the greater ſolubility of the animal matter in this acid, its larger quantity of oxigen, which ſeizing the principles of this matter, inſulates and burns its carbon, employs its hidrogen with a portion of this carbon itſelf and of the oxigen in the formation of the kind of fat, &c. Theſe united effects are ſtill more numerous and more difficult to be well explained than thoſe produced by the ſulphuric acid, as there are more attractions acting at the ſame time; they are nevertheleſs very well adapted for making us acquainted with the nature of the animal ſubſtances and confirming what has already been enunciated reſpecting them.

10. The muriatic acid preſents nothing particular in its action upon the animal ſubſtances, neither do the phoſphoric or the vegetable acids; it is only a little more powerful than the latter. They all diſſolve the fibrous and muſcular part, reduce it into a kind of jelly; and at laſt they decompoſe and convert a part into ammonia, which ſaturates them. They coagulate the albuminous liquids, ſoften, and in part decompoſe the bones, as well as the cartilages; they alſo diſſolve the membraneous textures. It is believed that this effect takes place during life, by the abuſe of the vegetable acids, of the acetous and of the nitric acid, and that it is on this account that perſons who take them in abundance grow lean, and loſe even a portion of the bulk or of the thickneſs of

their muſcles. With reſpect to the oxigenated muriatic acid, it acts with a far ſuperior energy upon theſe ſubſtances. At the moment of its contact with thoſe animal liquids, it thickens, coagulates and condenſes them into flakes, into mucous fragments, and thus confirms what I have ſaid of the coagulation of this humour by the combination or the fixation of oxigen. It hardens the ſolids, makes them ſhrink and contract, weakens their colour without deſtroying it, and even brightens that of ſeveral of them. We ſhall ſee hereafter that its powerful action upon the humours and the organs of living animals, is calculated to throw ſome light, at a future period, upon their functions and phyſiology.

ARTICLE VI.

Of the Properties of Animal Matters derived from their Alterability by the Alkalis.

1. THE violent action of the cauſtic alkalis upon animal ſubſtances has long ſince been obſerved by chemiſts; but not knowing then either the pure ſtate of the alkalis, or the intimate nature of the organic compounds, they were neither able to explain this action, nor to avail themſelves of it for the purpoſe of aſcertaining the compoſition of theſe matters. It was a fact which they had obſerved, without

being able to deduce from it inferences uſeful for the advancement of the ſcience, and they contented themſelves with making ſome applications of advantage to ſeveral of the proceſſes of the arts, ſuch as the employment of fixed alkalis rendered cauſtic by means of lime, for the purpoſe of opening iſſues, extirpating indolent and ſteatomatous tumours, clearing the fat out of wool, &c. It is only ſince the riſe of the pneumatic doctrine that the action of the alkaline cauſtics upon animal matters has begun to be known and employed for the purpoſe of determining their nature.

2. It was firſt remarked that theſe re-agents acted in a much more powerful manner upon animal than upon the vegetable ſubſtances, and that whilſt they diſſolved the latter but ſlowly and with difficulty, they ſoftened and diſſolved the former with rapidity: it was alſo perceived that all animal textures treated by cauſtic alkaline leys loſt their ſtrength and their weight, whilſt thoſe of vegetable filaments were but very little altered by them. To this action is to be attributed the kind of greaſy and unctuous feel which we perceive when we rub the cauſtic leys between the fingers; a phenomenon which cauſed the name of *oil of tartar* to be given to the concentrated ſolution of pot-aſh. This ſolubility of the animal matters takes place even by the ſolid fixed alkalis, becauſe they find a ſufficiency of water in theſe matters

to become firſt ſoftened and diſſolved, whence they are afterwards enabled to act as ſolvents.

3. In 1782, Citizen Berthollet publiſhed a Memoir upon this action of the alkalis: he repreſented it as the effect of a ſimple combination, into which the animal matters entered intire: he remarked that wool, ſilk, fleſh, boiled with a concentrated ley of pot-aſh, were diſſolved in it, deprived it of its cauſticity, gave it a bitter taſte, and a red colour, but did not take carbonic acid from it, as Macbride had believed; that this ſolution was precipitated by the acids and the metallic ſalts; that in the latter precipitation, the depoſit, compoſed of animal matter and oxide approaching to the metallic ſtate, was unalterable and not imprutreſcible; that it did not precipitate the ſuper-oxigenated muriate of mercury, whilſt a ſolution of ſugar and of ſtarch in the ſame alkali did not deſtroy its cauſticity but decompoſed this metallic ſalt; that the animal matter thus ſaturated the alkali.

4. A phenomenon obſerved by the ſame chemiſt induced me to adopt an opinion different from his; it led me to make a ſeries of experiments which furniſhed me with another theory, by ſhowing me that ſomething different from a ſimple ſolution took place. Citizen Berthollet had remarked that the ſolution of an animal matter by cauſtic alkali exhaled a diſagreeable putrid ſmell. I ſoon found that in fact every ſubſtance of this nature diſengaged a remarkable quantity of ammonia at the moment when it

was treated by a ſtrong alkaline ley; that at the ſame time caloric was diſengaged; that the ſame circumſtances took place, though with leſs energy, with lime, ſtrontian, and barites As a freſh animal matter does not contain ammonia ready formed, I concluded that it was formed from it by the action of the alkalis, that after this the matter being once diſſolved was no longer the ſame as before its ſolution, but that its nature was changed. In the preparation of the animal ſoap which is manufactured according to the recommendation and the advice of Citizen Chaptal, by boiling ſhreds of woollen ſtuffs in a ſtrong ley of pot-aſh, till it diſſolves no more of them, this liquid and coloured ſoap, uſeful in the manufactories of flannels, of cloths, and of blankets, retains and gives to the ſtuffs a diſagreeable ſmell which proceeds from this ammonia that is formed, and is diſſipated in the air by much waſhing.

5. It is eaſy to conceive that in proportion as ammonia is formed, the animal matter loſing five times as much azote as hidrogen, muſt contain in its portion united with the alkali much more hidrogen than before, and that having thus contracted an oily character its alkaline combination is a real ſoap; accordingly, all the properties deſcribed by Citizen Berthollet in this ſolution are ſo many characters of a ſaponaceous compound. The acids decompoſe it and ſeparate from it a concrete brown

oil; the metallic ſolutions form in it inſoluble precipitates of ſoaps; and the ſame is the caſe with the earthy ſalts. Citizen Chaptal has propoſed it to anſwer the purpoſes of a real ſoap in the woollen manufactures. It is evident that there is no proof wanting to my opinion.

6. The red or brown, more or leſs deep colour which animal ſubſtances aſſume when they are diſſolved in the cauſtic ley of fixed alkalis, indicates alſo another change of theſe ſubſtances. It is eaſily conceived that when azote and hidrogen is ſeparated from them to form the ammonia which is diſengaged, a portion of inſulated carbon muſt be precipitated, and that the oil then formed muſt approach to the nature of thoſe which are called empyreumatic. Petit obſerved, in 1733, in the Memoirs of the Academy of Sciences, that a piece of lapis cauſticus ſurrounded with fat and ſkin, rendered theſe parts reddiſh by remaining in them for ſome hours. Poulletier de la Salle has deſcribed, in his Commentary upon the Pharmacopeia of London, experiments made upon the application of the lapis cauſticus to the ſkin of a dead body, in which he obtained the ſame reſult. This agent, employed with the ſame care and the ſame apparatus upon the living ſubject, produced an eſchar, an excavation, with a margin of a livid-red colour, owing to its colouring action upon the ſubcutaneous fat.

7. This action of the alkalis, which at preſent is well aſcertained, explains their uſe as

cauſtics for removing malignant ulcers, indolent humors; it is evident how their employment as ſolvents for the diſeaſes which require this kind of remedies, may become dangerous if abuſed; how the alkaline leys alter and weaken all the animal textures which are impregnated with them, or left to remain in them, and eſpecially if heated with theſe liquors; as is frequently practiſed with wool, ſilk, hair, feathers, &c.

ARTICLE VII.

Of the Action of the Saline Subſtances, the Oxides and the Metallic Salts upon Animal Subſtances, conſidered as Character of theſe Subſtances.

1. I COMBINE in a ſingle article the action of three kinds of ſubſtances upon animal matters, becauſe it is either weak or difficult to be determined, or not yet appreciated with accuracy. There are few facts to be deſcribed, and few reſults to be deduced from the action of theſe bodies: it was, therefore, neceſſary that I ſhould conſider them together, not to ſeparate them, but aſſociate them in one conſideration.

2. The preſervative property which the ſalts ſhow with reſpect to all the organic ſubſtances in general is well known, and a number of arts

and proceſſes eſpecially prove the exiſtence of this property with reſpect to the animal matters. Alum hardens ſkins and contracts their texture, which it renders more durable; its ſolution is frequently employed in order to preſerve, againſt every kind of alteration, the organs or the parts of animals in anatomical collections. The muriate of ſoda produces a ſimilar effect, which preſerves meat ſo well, that it is employed in order to prevent its ſpoiling and to adapt it for nouriſhment. The ſame proceſs is employed for butter and cheeſe. Pringle imagined that a ſmall doſe of ſalt accelerated their putrefaction, whilſt a large one was antiſeptic: this opinion has been found to be an error, and that a ſmall quantity of ſalt ſuffers the animal matters to putrefy, only becauſe it does not abſorb the whole of their humidity.

3. The earthy ſalts, whilſt they preſent the property of the preceding, exhibit another character in their active energy upon animal matters; they decompoſe their ſoluble phoſphates, namely, thoſe of ſoda and ammonia, which are almoſt conſtantly contained in the liquors of animals: hence it comes that when we pour ſolutions of nitrates and muriates of lime, magneſia, or ſtrontian, into the ſerum, whey, urine, the water of hydropic caſes, or water in which fleſh has been boiled, &c. a more or leſs abundant precipitate is produced, which is always phoſphate of lime. The ſoda which exiſts inſulated, or in the ſaponaceous ſtate in ſeveral of

theſe liquors and in the bile, alſo decompoſes theſe ſalts and precipitates their earthy baſes; ſo that this precipitate is frequently two-fold and conſiſts of earthy phoſphates and earth. In the caſe of the ſaponaceous animal liquors, the precipitate which is formed is an inſoluble earthy ſoap. The aluminous ſalts, whilſt they produce the ſame effect upon the coloured liquors, frequently deprive them of their colour, with the matter of which alumine has a ſtrong affinity.

4. It is evident from this expoſition that the ſaline matters have almoſt always a very complicated effect upon the liquid animal ſubſtances, a part of the ſalts of which they decompoſe, becoming decompoſed themſelves, eſpecially when they are of an earthy nature, and that they preſerve theſe matters when ſolid, and condenſe their texture. We muſt, therefore, confine ourſelves to theſe effects the generality which it is here neceſſary to preſent; we ſhall hereafter have occaſion to give an account of ſome other actions exerted by the ſalts upon ſeveral animal ſubſtances in particular, to ſhow that theſe actions depend upon the ſpecial nature of theſe ſubſtances, and that they ought to be conſidered as very proper for characteriſing them. It can ſcarcely be doubted that many ſalts with an alkaline baſe, which are not found in the animal compounds, produce in theſe compounds phenomena of decompoſition, or of triple and perhaps quadruple union, which have not yet been

determined. Much ſtill remains to be done for the Science in all theſe reſpects.

5. Thoſe metals which are the moſt eaſily oxided undergo this kind of alteration, when they are kept immerſed in ſeveral animal liquids. Iron, zinc, lead, and copper belong eſpecially to this order; their oxidation is more particularly ſpeedy and more marked in the albuminous liquors. This ſlow combuſtion is frequently ſucceeded by a real phoſphatization, by the union of the metallic oxides with the phoſphoric acid of the animal matters. Every one knows how eaſily ſilver becomes coloured and blackened by the contact of theſe matters, and even of the vapours which exhale from them. The ſulphurated hidrogen gas with which they are frequently charged is the ſource of this alteration; the ſulphur which abandons it, unites in the courſe of time with this metal, and it was the cauſe of the ſulphuret of ſilver formed by plates of this metal, which had remained for a long time in a privy at Compeigne, and were examined in 1765 by Macquer. Even the metals that are the leaſt eaſy to be oxidated, nevertheleſs aſſume this ſtate by trituration with thoſe animal liquors which quickly abſorb this principle. It is in this manner that mercury, gold and ſilver, triturated with ſaliva and fat, are converted in a longer or ſhorter time into real oxides when they have the contact of the air.

6. The highly oxided metallic oxides, on the contrary, yield a more or leſs conſiderable portion of their oxigen to the animal matters with which they are placed in contact. It is in this manner that thoſe of mercury and of ſilver thicken and coagulate the albumen: ſome of thoſe which adhere the leaſt with it, and ſuffer it to be taken from them with more or leſs facility, even burn the animal compounds. Acknowledged as cauſtics, when they are applied to theſe compounds in the living ſtate, they may ſerve for making their analyſis when they are deprived of life. The animal matters are reduced into coal by the action of theſe oxides; whilſt it takes place water is formed, ſometimes ammonia, and in other circumſtances, nitric acid. It is on this account that the red oxide of iron, mixed with the animal ſubſtances employed in the artificial nitre-beds, contributes to the formationof this acid.

7. The ſolutions of the metals in the acids, act by both their component parts upon the animal liquors; there is not one of them that is not decompoſed, and the oxide of which is not ſeparated and approached to the metallic ſtate, by remaining in this liquor. Thoſe of the white metals, and eſpecially of mercury, and lead, and of ſilver, are precipitated at the very moment of their mixture with theſe liquors. This precipitate is formed either by the muriatic acid, or by the phoſphoric acid, which form part of the elements of theſe matters; the

ſoda which they contain, alſo contributes to it; the albumen, which frequently conſtitutes a portion of them, by taking oxigen from the oxides of the ſolutions alſo produces their ſeparation from the acid: ſometimes even the ſulphurated hidrogen diſſolved in the animal liquids, enters for ſomething into the precipitation; ſo that the precipitates obtained in theſe operations may be compoſed of five different matters; namely, of a phoſphate, a muriate, a ſimple metallic oxide, and the ſame oxide albuminated and ſulphurated: a delicate analyſis made ſlowly by means of different acids, may exhibit each of theſe metallic precipitates, and even give the proportions.

8. The action of the metals and of the metallic oxides and ſolutions upon the animal ſolids, has not yet been examined with ſufficient accuracy for it to be poſſible to deſcribe it with exactneſs. It is known that theſe ſolids are preſerved by theſe ſolutions; that they become coloured, condenſed, contracted, and hardened; that they abſorb a portion of the metallic ſalt; that they decompoſe another and ſeparate from it the oxide which they approach to the metallic ſtate; that they at the ſame time ſuffer an alteration more or leſs conſiderable, according to the differently concentrated ſtate of the ſolution, and that in the frequently dark colour which they acquire, their carbon is inſulated, and their hidrogen burned. The moſt acrid and moſt cauſtic ſolutions burn and entirely deſtroy the texture of the animal

ſolids, by reducing them to a complete coally ſtate: it is for this purpoſe that they are employed in ſurgery.

ARTICLE VIII.

Of the Action of Vegetable Matters upon the Animal Subſtances, conſidered as Generic Characters of the latter.

1. THE entire vegetables, or the different immediate materials of vegetables, have not nearly ſo powerful an action upon the animal ſubſtances as that which they exert upon moſt of the preceeding ſubſtances; the effect which they produce upon them is frequently almoſt inſenſible. It is not obſerved, that they tend to diſorganize them, to decompoſe them, or to deſtroy the equilibrium which exiſts between their conſtituent principles; we conſequently find that they cannot be uſed for analyzing them. This action, however, is not a nullity; though it is feeble, it does not the leſs merit to be examined with attention, and deſcribed with care: we find in it phenomena which may add to the chemical characters of the animal ſubſtances, and contribute to the underſtanding of their nature.

2. Formerly we judged by the taſte of plants of their medicinal virtues, which ſome phyſicians had attributed to their chemical properties; but the erroneous notions which they had formed of the analogies of theſe two kinds of pro-

perties are now baniſhed by a ſound theory; and they no longer form a part of the ſcience. It was thought that the juices of the vegetables mixed with the animal liquors ought alſo to ſhow, in their ſenſible action upon theſe liquids, the nature of their action in diſeaſes; ſome were ſolvent or attenuant, others inſpiſſant and incraſſant, ſome anti-putreſcent, others aſtringent and condenſing, others again ſeptic. It has been aſcertained that theſe experiments were not only mere chimeras as to the theraputic theory, but alſo real errors with reſpect to the chemical effects, which are ſtill too much complicated, even at the preſent day, when the ſcience is ſo much farther advanced, to be capable of being well determined.

3. We may with greater facility appreciate the immediate, though feeble effects, produced by the immediate materials of plants, when ſufficiently pure and inſulated, upon the animal matters. The mucilages diſſolve in their liquids, and frequently precipitate from them ſuch materials as are leſs ſoluble than thoſe which they contain. Sugar, whilſt it produces this firſt effect, acts beſides as a preſerver: ſometimes by its ſolution it favours the alterability and fermentability of which they are ſuſceptible. It has already been ſeen that the vegetable acids coagulate the albumen, diſſolve the fibrin and the gelatin, and prevent or retard their alterations.

4. All the inflammable oily bodies, all the materials of vegetables in which hidrogen ap-

pears to be the ſuperabundant principle, act in an uniform manner upon the animal ſubſtances. When covered with fixed oil, they keep, and frequently ſuffer themſelves to be penetrated by it, like the ſkins which thus acquire pliability; the animal mucilages, the albumen, and the gelatin, render it miſcible with water by agitation, and ſuſpend it in emulſion; oil diſſolves the fats with the aid of heat.

The volatile oils, the balſams, the reſins, camphor, preſerve the animal ſubſtances from putrefaction: on this account they were employed by the nations of antiquity for the purpoſe of preſerving dead bodies in embalming.

So ſtrong and ſo marked an attraction is obſerved between the vegetable colouring matters and the animal textures; and this is ſo well demonſtrated by the ſolidity of the dyes applied to wool, ſilk, &c., that in order to make vegetable threads approach to the ſame ſolidity, they are ſucceſsfully impregnated with fat or animal oil, which diſpoſes the colouring matter to adhere to them.

The ligneous matter itſelf, however inert it may appear, is not entirely void of action upon the animal matters: when reduced into powder and thrown upon their ſurface, it dries it, abſorbs their moiſture, hardens them and preſerves them from alteration.

5. The different vegetable materials hitherto indicated are almoſt inert in compariſon with three other vegetable ſubſtances, the energy of

which upon the animal compounds is infinitely ſtronger: theſe are the tannin, the gallin, and alcohol; each of them deſerves to be examined ſeparately. I have already upon a former occaſion ſpoken of the nature and general property of tannin; and I muſt hereafter treat with ſome detail of the cutaneous texture; it will, therefore, be uſeful here only to ſtate the general impreſſion which the animal matters experience from this ſubſtance. Tannin diſſolved in water precipitates the albumen and gelatin from their natural ſolutions or from the animal liquids which contain them. The precipitate, eſpecially that of the gelatin or glue, is ſoft, fawn coloured, ductile; it hardens and becomes brittle by drying: it is then inſoluble and unalterable This precipitation is ſo well adapted for characterizing the animal ſubſtances and eſpecially the gelatin, that by its quantity we may determine that of this principle as well as aſcertain its preſence. It is alſo found that tannin, which has become an uſeful re-agent in the animal analyſis, is the moſt powerful of the vegetable antiſeptics, ſince tanned ſkins experience no more ſenſible alteration and keep a long time without change. This property will, at ſome future period, afford an uſeful application to medicine; it may already be employed with advantage for anatomical preparations and for preſerving membranous organs.

6. *Gallin* I term the impure gallic acid, combined with a ſmall portion of extractive, or of a vegetable principle hitherto unknown, in which its aſtringent taſte principally reſides. It exiſts almoſt always along with the tannin; it is not abſorbed by the animal matters, nor precipitated by the ſolution of glue: ſo that water ſaturated with tan, and afterwards deprived of tannin by the ſkins which have taken it from it, contains this gallin which is exhibited in it by precipitating the ſulphate of iron. Mr. Prouſt has ſeparated the gallin from the tannin, both contained together in a decoction of gall-nuts, by uniting it with muriate of tin which ſeizes the tannin by which the oxide of tin is precipitated, and leaves in the ſupernatant liquor the gallin with the muriatic acid. Citizen Seguin has diſcovered in the gallin the property of diſoxigenating or unburning animal matters, and of diſtending them, by ſwelling them in ſuch a manner as to diſpoſe them by this double effect to combine with the tannin. The uſe of the gallin as a re-agent may hereafter be carried ſo far as to enable us by its means to aſcertain the ſtate of oxigenation of the different animal ſubſtances.

7. Alcohol, the product of a ſpontaneous alteration of the ſaccharine matter that has been elſewhere deſcribed, has itſelf a very marked action upon the animal compounds; its effect is fourfold upon theſe compounds according to their different nature: it diſſolves ſome

and may ſerve to ſeparate them; it coagulates others; ſome it preſerves and even hardens their texture.

It effects the ſolution of the animal reſins, of ſome colouring parts of animals, of ſeveral of their acids, of certain fats, eſpecially of that which I call *adipocire,* and which is found in the dried liver, in biliary calculi, &c.

It coagulates the albuminous liquids; it precipitates from them the albumen in ſmall flakes almoſt pulverulent which may be diſſolved in water, as Bucquet has remarked, at the moment when they have juſt been precipitated.

It preſerves and defends againſt putrefaction almoſt all the animal matters liquid or ſolid: it is employed for this purpoſe in anatomical laboratories, and even in medicine.

Finally, it hardens the texture, contracts and condenſes the fibres of moſt of the ſolids of animals; it condenſes and hardens their plates and laminæ.

ARTICLE IX.

Of the Property of Forming Pruſſic Acid and ſome other Acids, conſidered as Character of the Animal Compounds.

1. THOUGH the diſcovery of Pruſſian blue, made in the firſt years of the eighteenth century by Dieſbach and Dippel, two chemiſts of Berlin, had at firſt only a colouring matter uſeful in painting for its object, it might ſince that time be thought that it would have a direct influence upon animal chemiſtry, as it really belongs to the ſubſtances of this nature, and was made by a chemiſt who had much occupied himſelf with theſe ſubſtances. However its relations with this kind of analyſis, and the characters which I now derive from it in order to diſtinguiſh the animal ſubſtances, were not very perceptible till after the experiments of Citizen Berthollet in 1787, and eſpecially till after a diſcovery made by myſelf, in 1790, upon the production of the Pruſſic acid, during the treatment of animal matters by the nitric acid. It required the labours of nearly eighty years to aſcertain this influence; and this is the reaſon why I think it incumbent upon me to give a ſomewhat detailed hiſtory of theſe

labours, or at leaſt of the principal epochas which conſtitute it.

2. It was a little before the year 1710, that Dieſbach, having borrowed from Dippel ſome alkali, in order to precipitate a lake, or extract from ſulphate of iron, accidentally obtained a very beautiful blue. The latter chemiſt, knowing that this alkali had repeatedly ſerved him for diſtilling and rectifying animal oils, eaſily reproduced this colour by precipitating ſulphate of iron with a ſimilar alkali. This diſcovery was announced in the Memoirs of the Academy of Berlin, in 1710. In 1724, Woodward deſcribed, in the Philoſophical Tranſactions, the firſt proceſs for preparing this new blue, which made much noiſe. It conſiſted in calcining in a crucible equal parts of ox-blood and pot-aſh to redneſs, lixiviating the product with boiling water, mixing this lixivium with a ſolution of ſulphate of iron and of alum, and employing muriatic acid in order to brighten the blue, which was waſhed with a large quantity of water. This very good proceſs is ſtill in a great meaſure followed in the workſhops The name of *lixivium of blood* was given to the liquor obtained from the alkali treated with this ſubſtance, afterwards diſſolved in water, and thus diſpoſed to precipitate the iron in the blue ſtate.

3. The chemiſts zealouſly laboured upon this proceſs, and at firſt ſought various means for rendering the alkali capable of producing this

colour. Brown, in 1724, found that the alkali treated with fleſh acquired this property in the ſame manner as with blood; and he endeavoured to explain its formation by means of a bituminous principle of iron, developed by the blood, and fixed upon the alumine. Geoffroy, the phyſician, diſcovered in 1725, that oil, wool, hartſhorn, ſponge, and even thyme calcined with alkali, give it the ſame action upon the ſulphate of iron; he thence explained the blue before deſcribed in ſoda treated with the acids by Henckel: and he adopted the theory of Brown. Neuman endeavoured to treat the alkali with many different oils, and ſucceeded in communicating to it the tinging property by theſe inflammable bodies. Menon gave, in the Memoirs des Savans étrangers of the Academy of Sciences of Paris, a new theory of Pruſſian blue: he pretended that blue was the natural colour of iron, and that blood inſulated it by purifying or refining this metal. Thus forty years paſſed without any other notion being added to the firſt diſcovery, except the poſſibility of obtaining blue with various matters different from blood, eſpecially animal ſubſtances.

4. In 1752, Macquer, in an excellent Memoir, inſerted amongſt thoſe of the Academy of Sciences, advanced the theory of this preparation a conſiderable ſtep farther, by diſcovering the diſcolouration of Pruſſian blue by the alkalis. He ſhowed that the alkaline leys became ſaturated

this colouring matter, by cauſing them to paſs over Pruſſian blue till they ceaſed to diſcolour it, and again formed an abundant quantity of pure blue, when they were poured into a ſolution of ſulphate of iron; that theſe ſaturated leys were in a ſtate different from that of the immediate ley of blood, as this did not directly precipitate the iron into the blue, but in the grey or green ſtate, on account of the portion of alkali not ſaturated. He ſuſpected that the colouring matter ſaturated the alkalis after the manner of an acid; that it adhered to them much in the ſame manner as to iron, ſince the ſimple acids, according to him, did not diſengage it from them; that in order to take it from them and transfer it to the iron, it was neceſſary to employ a double affinity. He ſubſtituted, inſtead of the vague theory of Brown and Menon, that of the alkali ſaturated by *phlogiſton;* this was transferred again to the iron, which it ſurcharged by ſeparating it from the acids.

5. More than twenty years elapſed after the ingenious labours of Macquer, without any thing being added to his doctrine, which was adopted by almoſt all the chemiſts, who were then ſatisfied with it. They contented themſelves with proſecuting their reſearches concerning the bodies capable of *phlogiſticating*, as they expreſſed it, the alkali; Weiſman found this property in the empyreumatic oils; Model, in ſoot; Cartheuſer in ſeveral vegetable aſhes;

Jacobi,

Jacobi, in the coal of the vine; Spielman, in the bitumens, and Goettling, in the funguſes. Till 1775, no change or modification of the theory of Macquer was propoſed.

6. At this laſt epocha, Bergman, in his Diſſertation upon the Elective Attractions, began to throw ſome new light upon this ſubject, by repreſenting the colouring matter of the Pruſſian blue as a diſtinct acid, having its particular attractions. Several chemiſts, amongſt others Delius and Scopoli, beſtowed much more attention upon the products of the Pruſſian blue by fire; they remarked that it afforded much ammonia. Citizens Deyeux and Parmentier obſerved, that when treated with lime and the fixed alkalis, a conſiderable quantity of this volatile alkali was diſengaged from it. It was then ſuſpected that it contained its materials like the animal ſubſtances, and this idea undoubtedly guided the chemiſts who afterwards undertook reſearches upon this ſubject. Mr. Fontana found that the ſulphuric acid, diſtilled upon Pruſſian blue, paſſed into the ſulphureous ſtate, and that this coloured ſubſtance detonated with nitre. Mr. Landriani diſcovered that it yielded, in its diſtillation, beſides ammonia, a mixture of azotic gas and of hidrogen gas, burning with a blue flame, and not detonating with oxigen gas.

7. Theſe were in ſome meaſure preludes to the important diſcoveries of Scheele, who ſuddenly raiſed himſelf above all thoſe who had

occupied themſelves with this ſubſtance. This celebrated chemiſt undertook to aſcertain, both the compounds of which the Pruſſic acid forms a part, the properties of this acid, which before him no one had been able to inſulate, and its intimate nature, by decompoſing it, and alſo by forming it in a direct way with materials leſs complicated than the animal ſubſtances. His diſcoveries upon theſe different points are contained in two Memoirs inſerted in the Trimeſtres of the Academy of Stockholm, of December 1782, and January 1783. He began with examining the ley of blood: he ſaw that it was altered by the contact of gaſeous carbonic acid; that this acid diſengaged from it a vapour, which converted ſulphate of iron placed upon a ſtopper at the top of the apparatus into blue; that the ſulphuric acid alſo ſeparated it from it with the aid of diſtillation; that the Pruſſian blue, diſtilled with this acid, yielded an elaſtic fluid, which tinged the oxide of iron blue; that, when diſtilled alone, the Pruſſian blue yielded a portion of this colouring vapour, and ammonia ſaturated with it; that the ley of blood diſſolved a ſmall quantity of oxide of iron, which rendered it more ſolid and more permanent; that the iron eminently poſſeſſed the property of fixing the Pruſſic acid; that fire and the acids were nevertheleſs capable of volatilizing this colouring matter; that an alkaline ley, whilſt it diſcoloured the Pruſſian blue, diſſolved a ſmall portion of it entirely, and thus acquired a more durable character than the ley of blood; that an acid diſtilled with the pruſſiate proceeding from the diſcolouration of the Pruſſian blue, precipitated from it an abundant quantity of real Pruſſian blue, becauſe it was decompoſeable only in its portion of alkaline Pruſſiate, and not in its ferruginous Pruſſiate.

8. After having diſcovered the poſſibility of obtaining the colouring matter of Pruſſian blue ſeparate, and being able to obſerve its properties in its pure ſtate, he ſought the moſt ſpeedy and moſt certain means of effecting this ſeparation, which till then had been unknown to the chemiſts, who had not yet had this matter otherwiſe than combined with the alkalis and the metals: Scheele preferred the following proceſs, which has been practiſed ſince his time. Two parts of Pruſſian blue, and one part of red oxide of mercury, are boiled in ſix parts of water till the whole is decolourated: to the lixivium is added half a part of iron-filings, and a little leſs of ſulphuric acid; the mixture is diſtilled, and nearly a fourth of the liquor is drawn off, which is rectified by diſtilling it again upon chalk, in order to abſorb the portion of ſulphuric acid which it may contain. In this operation, the oxide of mercury takes away the Pruſſic acid from the oxide of iron, and is diſſolved in Pruſſiate of mercury, white, cryſtallizable, &c. The iron, which is added in the metallic ſtate, reduces the oxide of mercury, and at the moment when it unites with the ſulphuric acid, added at the ſame time,

the heat which is employed volatilizes the Pruſſic acid ſeparated from the mercury, which has been reduced to the metallic ſtate. The Pruſſic acid thus obtained, partly in liquor and partly in gas, produces, when united with the alkalis, the ſame effects as the leys of blood and of decolourated Pruſſian blue. We ſhall ſoon return to its diſtinctive characters.

9. Scheele was not content with having found the means of inſulating and obtaining pure the colouring matter of Pruſſian blue or the Pruſſic acid; he wiſhed alſo to aſcertain what it was compoſed of, and conſequently to know how it is formed in animal matters. In order to determine its conſtituent principles, he firſt obſerved, that in the proceſs of abſtraction the air of the receiver was inflammable; that in decompoſing the Pruſſiates by fire, he obtained ammonia and carbonic acid; that ſome metals were afterwards found reduced by the diſtillation of theſe metallic Pruſſiates. He then ſuſpected that this acid was compoſed of ammonia and oil, and directed his ſubſequent reſearches upon this ſuppoſition; but he could not ſucceed in forming the colouring compound with ammonia and different oils or fats heated together. Obſerving that the water was an obſtacle to this formation of Pruſſic acid, he conducted his experiments in a different manner, by uniting ammonia with the dry inflammable principle which he admitted in the oils, and with the carbonic acid alſo dry.

He ſaw that the coal alone, heated ſtrongly with fixed alkalis, gave them the property of colouring iron blue. Having heated theſe two matters in crucibles, he added in one muriate of ammonia at the moment when the firſt mixture was heated to incandeſcence, and he continued to heat it till no vapour was diſengaged. This proceſs afforded him a ley which produced much Pruſſian blue, whilſt the operation in which he had contented himſelf with heating the alkali and the coal without addition of muriate of ammonia, afforded only an inappreciable quantity of it.

10. Scheele concluded from theſe laſt experiments, that the Pruſſic acid or the colouring matter of Pruſſian blue was a compound of ammonia and of a very ſubtile highly attenuated coal; that this compound, having become fixed by the ſtrong heat with which it was formed, united with the fixed alkali, which it rendered capable of precipitating Pruſſian blue, or that the alkaline Pruſſiate, the Pruſſian alkali, was only a compound of alkali, coal and ammonia,—that in the diſtillation of the Pruſſian blue, the fire abſorbed the inflammable principle and ſuffered the carbonic acid and the ammonia to be diſengaged; that a ſmall quantity of Pruſſian acid was ſeparated undecompoſed; and laſtly, that the oxide of manganeſe heated with it, rendered its decompoſition complete. The Pruſſic acid, extracted by his proceſs had, according to him, as its characters, a ſmell like that of the bloſſoms

of the peach tree, a taſte ſweetiſh at firſt, afterwards acrid and burning, the property of not reddening the blue colours, but of precipitating ſoap and the alkaline ſulphurets, that of combining with the alkalis, and of forming ſalts capable of precipitating the metallic ſolutions, and eſpecially thoſe of iron in the blue ſtate. He diſtinguiſhes amongſt the ſaline compounds of this acid, the Pruſſiate of lime, which he recommends, as being very pure, to ſerve as a teſt proper for aſcertaining and indicating the preſence of iron with certainty in waters, &c.; a teſt which the chemiſts have ſought with much care for a great number of years paſt. Two years before the labours of Scheele, in 1780, I employed this calcareous Pruſſiate, in my courſes of Lectures, as a teſt for aſcertaining the preſence of iron.

11. Such was the ſtate of the Science with reſpect to the colouring matter of Pruſſian blue, or the Pruſſic acid, when Citizen Berthollet communicated, at the cloſe of the year 1787, to the Academy of Sciences, a new inquiry in which he employed with great ſagacity, and by the aid of the new data of the French pneumatic doctrine, the experiments of Scheele, adding to them ſeveral others, and converted the ſtill uncertain and inadmiſſible theory of the French chemiſts into an explanation that agreed much better with the views of the modern chemiſtry. The reſult of his inquiry was, as it were, the reſult of the light which he had

thrown upon the nature of ammonia ſome years before. The compoſition of the one, once well known, muſt in fact have neceſſarily conducted him to the knowledge of the other, ſince even the reſearches of Scheele had already ſhowed a ſingular analogy between theſe two compounds, equally abundant amongſt the products of the animal matters.

12. The French chemiſt firſt proves that the alkaline Pruſſiate, formed by the diſcolouration of the Pruſſian blue, by means of alkali, contains iron; that its lixivium, being evaporated and afterwards re-diſſolved, yields octahedral cryſtals, the points of which are truncated near their baſes; that, mixed with ſulphuric acid and expoſed to the ſun, its ſolution depoſits Pruſſian blue, and is decompoſed; which does not happen to it in the ſame manner in the ſhade; that the Pruſſiate of mercury cryſtallizes in four-ſided priſms, terminated by pyramids with four faces correſponding with the edges of the priſms; that the muriatic acid diſengages more Pruſſic acid from it than the ſulphuric acid; that this acid, in decompoſing the Pruſſiate of mercury, forms a muriate in a ſingular ſtate.

13. After theſe preliminary experiments, he proceeds to the examination of the intimate nature of the Pruſſic acid by the action which the oxigenated muriatic acid exerts upon it. The latter, in proportion as it diſſolves in the Pruſſic acid, returns to the ſtate of ordinary

muriatic acid; the Pruſſic acid becomes more odorous, more volatile, leſs ſuſceptible of uniting with the alkalis, and precipitates iron in the green ſtate from its ſolutions. This green precipitate again becomes blue in the light by the contact of the ſulphureous acid, by iron: it is the oxigenated *Pruſſic* acid. By accumulating in it new oxigenated muriatic acid, which is made to paſs into it in gas, and by expoſing it to the light, water is ſeparated, to the bottom of which it is precipitated in the form of an aromatic oil, which heat reduces into an inſoluble vapour, that can no longer unite with iron. Thus ſuper-oxigenated, this acid can no more return to its firſt ſtate; it is far remote from its primitive nature.

14. The oxigenated Pruſſiate of iron, which is alſo prepared by treating the Pruſſian blue with the oxigenated muriatic acid, and is diſtinguiſhed by its green colour, loſes its acid which is ſuddenly converted into carbonate of ammonia by the contact of a fixed cauſtic alkali. The Pruſſic acid does not contain ammonia ready formed, as Scheele and Bergman thought; it contains only its elements, azote and hidrogen, both combined with carbon. When a ſufficient proportion of oxigen is added to this combination, the ſucceſſive addition of an alkali or of lime quickly deſtroys the Pruſſic compound by the pre-diſpoſing attraction which they have for the carbonic acid. Accordingly, Citizen Berthollet has been led by his experi-

ments to conſider the Pruſſic acid as a combination of three ſimple combuſtible bodies; hidrogen, carbon and azote, the proportions of which, however, he has not found, though he has announced that thoſe of the hidrogen and azote approach to the ammoniacal compoſition.

15. This reſult, which is much more preciſe than that of the Swediſh chemiſt, has furniſhed Citizen Berthollet with the means of eaſily explaining the principal phenomena which the Pruſſiates preſent, as well as the formation of the Pruſſic acid. The following are the facts which he has eſpecially conſidered under this new point of view:

A. The metallic Pruſſiates diſtilled, yield carbonated hidrogen gas and carbonate of ammonia, and their oxides are more or leſs reduced; for the oxigen of the oxides, ſeizing the carbon, leaves the azote and the hidrogen to unite with one another; the oxigenated muriatic acid acts in the ſame manner.

B. The animal matters form Pruſſic acid in proportion to the azote they contain, which combines with the hidrogen and carbon.

C. In the experiments of Scheele, the muriate of ammonia heated with fixed alkali and charcoal is decompoſed: it is by the elements of the ammonia and not by the entire ammonia that this ſalt contributes to the formation of the Pruſſic acid.

D. The

D. The hidrogen, which forms part of this compound, is the cauſe of the violent inflammation produced eſpecially by the ſuper-oxigenated muriate of pot-aſh.

16. Citizen Berthollet, not having found oxigen in his experiments of decompoſition upon the Pruſſic acid, thinks himſelf authorized to conclude from thence that this acid contains no acidifying principle. On this occaſion he examines the ſingular nature of this compound; though he diſcovers in its properties very remarkable differences between it and the other acids, he thinks, however, that it approaches the neareſt to the nature of theſe bodies, and that it ought to be ranked in their claſs. He eſpecially inſiſts upon its analogy with ammonia, and the tendency which it has to paſs into the ſtate of this volatile alkali. He terminates his inquiry by the explanation of a very ſingular phenomenon of attraction which the Pruſſic acid preſents, and which Scheele had conſidered as an ~~irreſoluble~~ problem; namely, that it cannot be ſeparated from the metals by the other acids, and that, nevertheleſs, it cannot by itſelf take away from theſe acids the metallic oxides that are diſſolved in them. He explains the apparent contradiction in the doctrine of affinities, by the great quantity of ſpecific caloric which this acid when pure contains, and by the ſtrong tendency which it has to aſſume the gaſeous form.

17. We ſee from the ingenious reſearches of Citizen Berthollet that the production of the Pruſſic acid by the decompoſed animal matters, whilſt it exhibits one of the moſt proper characters for diſtinguiſhing them and aſcertaining their nature, preſents a property ſingularly related with that of forming ammonia. But in what does this property of affording Pruſſic acid or ammonia preciſely reſide? and what is the cauſe which determines the production of the one rather than the other? In order to ſolve this queſtion, which is of great importance to Animal Chemiſtry, it is to be obſerved, that the formation of ammonia ſuppoſes a more advanced decompoſition than that of the Pruſſic acid, as the one repreſents a binary compound, whereas we ſtill find in the other a ternary compound, more approaching to the nature of the primitive animal matter by its very complication. In the ſecond place, it is to be remarked that the production of the Pruſſic acid is not ſenſibly favoured, or does not take place in any abundance except when we treat the animal matters by a fixed alkali, eſpecially aided by a metallic oxide; it is, therefore, the pre-diſpoſing attraction, exerted by two bodies at the ſame time, which ought to be conſidered as the cauſe of this formation of Pruſſic acid. Finally, it muſt not be omitted, that the production of the Pruſſic acid never takes place except in a very ſmall quantity comparatively with that of the animal ſubſtances which afford it, that it

amounts only to ſome thouſandths or at moſt to two or three hundredths; and that the carbonate of ammonia which they afford is in a quantity twice or thrice as conſiderable, on account of the carbonic acid which ſaturates it, and which is formed at the ſame time.

18. In 1790, three years after the inquiry of Citizen Berthollet, I pointed out a new fact, which I thought adapted to elucidate the nature and the formation of the Pruſſic acid. In treating the ſerum of coagulated blood by the nitric acid, I was ſtruck with the ſmell of Pruſſic acid. The vaporous product diſengaged in this experiment having been collected, I found it to be real pure Pruſſic acid; I even obtained a ſufficient quantity of it to induce me to believe that this very ſimple proceſs might be ſubſtituted inſtead of that of Scheele, which is much more complicated, in order to obtain this acid; azotic gas had been diſengaged with it and carbonic acid gas was formed. This led me to think that a ſimple change in the proportions of the conſtituent principles of the animal matters was ſufficient to give riſe to the Pruſſic acid; and that, as in the formation of the nitric acid, azotic gas had at firſt been diſengaged, there was reaſon to believe that this acid contained leſs azote than the ammonia, ſince in the formation of the latter this principle was not ſeparated before that formation had taken place. It cannot therefore be admitted, either that the Pruſſic acid is a ſolution of carbon in ammonia, as

Scheele had preſumed, or that it contains azote and hidrogen in a proportion nearly approaching to that which forms ammonia, as Citizen Berthollet had announced. This opinion of the quantity of azote proportionably larger in the Pruſſic acid than in ammonia may even be ſupported by one of the facts which had been well obſerved by the latter chemiſt; I mean, the diſengagement of a certain quantity of carbonated hidrogen gas during the formation of the carbonate of ammonia, which accompanies the decompoſition of the Pruſſic acid by fire. Neither does it appear to me to be well proved that this acid ought to be conſidered as wanting oxigen, and as formed merely by the union of three ſimple combuſtibles, both becauſe Citizen Berthollet who has propoſed this opinion has not made an accurate analyſis of this acid, and becauſe the compariſon which he has eſtabliſhed between this acid, the muriatic acid, and the ſulphurated hidrogen, is very far from being equivalent to a proof; and finally, becauſe the conſtant production of the carbonic acid in all caſes of the decompoſition of the Pruſſic acid, even not previouſly ſuper-oxigenated, the ſix-times more conſiderable quantity of Pruſſic acid obtained by Citizen Vauquelin, in decompoſing muriate of ammonia mixed with charcoal by the oxide of lead, than that which he obtained in performing the ſame operation with lime inſtead of oxide of lead, militate ſtrongly in favour of the adoption of oxigen in this acidified compound.

19. The formation, the nature and the properties of the Pruſſic acid, as a characteriſtic production of the animal compounds, are ſo neceſſary to be accurately known in order that we may form a right conception of the properties of theſe compounds, that it appears indiſpenſable to me here to enumerate the ſeries of properties that belong to this important product, conſidering it as inſulated, and prepared either by the proceſs of Scheele, or by that which I have indicated (No. 18):

A. The Pruſſic acid has a ſtrong odour of peach-bloſſoms or of bitter almonds. This ſmell impregnates for ſome time the ſaliva of thoſe who reſpire it.

B. Its taſte, which at firſt is ſweetiſh, ſoon becomes acrid, hot and virulent; it excites coughing.

C. It has a great tendency to aſſume the gaſeous form, and frequently ſome of it is loſt in this form in the veſſels into which it is received.

D. It is decompoſed at a high temperature, and by the contact of light: it is thus changed into carbonic acid, ammonia, and carbonated hidrogen gas.

E. It combines with the alkaline baſes with difficulty, and without deſtroying their alkaline property.

F. Its weakneſs, already proved by the preceding property, permits the carbonic acid to diſplace it from the alkaline Pruſſiates.

G. It takes oxigen from the oxigenated muriatic acid, and its nature is changed by the addition of this principle.

H. It does not act upon the metals; it unites with their oxides, the colour of which it changes, and with which it forms in general inſoluble ſalts.

I. It has a great propenſity to form triple ſalts with an alkaline and metallic baſe. Theſe triple Pruſſiates, theſe complex combinations are more permanent and more fixed than the ſimple alkaline Pruſſiates; they are no more decompoſed by the carbonic acid, light, the air and the acids.

K. When it is united with the metallic oxides, it cannot be ſeparated from them by the acids, as in theſe combinations it acquires a great fixity and a great adherency; and yet when it is inſulated, it cannot carry off the oxides of the metals from the other acids, on account of its ſpecific caloric, and its tendency to aſſume the ſtate of gas.

L. According to the reſearches of Citizen Berthollet and Mr. Prouſt, there are two ſpecies of metallic Pruſſiates, the ſimple and the ſuperoxigenated: there is even reaſon to believe that with reſpect to iron there are three, the white, the blue and the green, the progreſſion being made from the moſt to the leaſt oxigenated.

M. The ſuper-oxigenated Pruſſic acid is very near to decompoſition; the mere contact of a fixed alkali deſtroys it and converts it into carbonate of ammonia, becauſe the oxigen being ſufficiently abundant, and attracting the carbon, permits the azote to unite in particular with the hidrogen to form ammonia; the hidrogen exceeding the proportion of the latter compoſition is diſengaged in carbonated hidrogen gas.

20. The nature, the compoſition, the decompoſition of this acid being once well demonſtrated, its relations with the animal matters which produce it are ſtill better determined by the conſideration of the different principal circumſtances of its production. I find four of them which equally demonſtrate a like ſeries of decompoſition that takes place in theſe matters.

A. The action of fire; we have ſeen that it is obtained amongſt the products of the bones, the blood, the urinary calculus; it is combined in them with ammonia.

B. The action of the nitric acid; when this acid is weak, it firſt diſengages azote from the animal matters; when it is ſtrong and concentrated, it immediately volatilizes Pruſſic acid from them, and at the ſame time are formed carbonic acid, oxalic acid, and the adipocirous matter.

C. The action of the fixed alkalis; the animal ſubſtances, heated by a ſtrong fire with the alkalis, ſaturate them in part with Pruſſic acid after they have been reduced to coal.

D. Finally

D. Finally putrefaction, by deſtroying the animal compoſition, ſometimes gives riſe to Pruſſic acid, which eaſily finding oxide of iron, combines with it and gives it a blue colour; hence proceed the native Pruſſian blues deſcribed by ſeveral naturaliſts.

21. What I have juſt ſet forth concerning the Pruſſic acid may be applied to ſome other particular acids of animals, though they be few in number; for we muſt not rank in this claſs the oxalic, acetous, ſebacic acids, which being found the moſt frequently amongſt the products of the vegetable matters, have the compoſition and all the chemical characters of ſuch matters. When theſe acids are formed in the animal ſubſtances they really belong only to theſe matters in a retrogradation towards their firſt origin, or in ſome meaſure deſcending, by a commencement of decompoſition, to the condition of vegetable ſubſtances. I know ſcarcely any other than the zoonic acid diſcovered by Citizen Berthollet, the uric acid conſtituting one of the ſpecies of the human urinary calculi, and one of the materials of arthritic concretions, the lactic acid, and perhaps the acids of inſects, which appear to belong to this claſs of animal acids, when they do not preſent all the properties of acetous acid, like the former acid. The moſt marked character of theſe animal acids is that they can be converted into Pruſſic acid by chemical means; they alſo deſerve to be examined anew under this point of view, eſpecially the zoonic,

the lactic, and the uric acids, which are very little known with reſpect to their intimate compoſition.

ARTICLE X.

Of Putrefaction, conſidered as Characteriſtic Property of the Animal Subſtances.

1. THE laſt and one of the moſt ſtriking characters which diſtinguiſh the animal from the vegetable matters, conſiſts in the kind of ſpontaneous decompoſition which they experience, and which is called putrefaction. Though the vegetable ſubſtances are not exempted from this decompoſition; though nature has ſubjected them to this law which equally embraces all the organic matters, the ſlighteſt obſervation is ſufficient to ſhow that putrefaction is infinitely more powerful and more rapid in the animal compounds, which are more diſpoſed to it by their very compoſition, and that it eſtabliſhes itſelf in them, develops itſelf and goes through its periods with much greater activity. It is not neceſſary to preſent it here as an inteſtine motion which tends to change the nature of the ſubſtances which experience it; for all that has already been ſaid, both in the hiſtory of the vegetable ſubſtances, and in the preceding articles concerning the animal matters render this ſufficiently evident.

2. It is already a long time ſince philoſophers and naturaliſts have acknowledged all the intereſt which the ſtudy of putrefaction preſents for the ſciences, and eſpecially for the art of healing. Lord Bacon firſt pointed out its utility for medicine; he was the firſt who invited phyſicians to occupy themſelves attentively with it, and eſpecially with the intention of diſcovering means for preventing it, retarding it, even ſtopping its progress, or re-eſtabliſhing the ſubſtances which had experienced it in their natural ſtate.

Becher has made a remarkable table of its phenomena, and enunciated its grand effects in the order and ſucceſſion of the changes which the globe experiences: Stahl his commentator has added nothing to this table.

Pringle, an Engliſh phyſician, has made a great number of experiments upon the ſepticity and antiſepticity of bodies, and has opened an immenſe career for the doctrine of antiſeptics.

Citizen Giobert of Turin has repeated them and added to them ſeveral new ones.

A French lady, who has rendered herſelf eminent by a great number of ſcientific productions, eſpecially by her tranſlation of Shaw's Courſe of Chemiſtry, has given a numerous ſeries of experimental inquiries upon the ſame ſubject.

Macbride, a ſurgeon of Dublin, opened a new career immediately at the firſt period of the diſcoveries upon the elaſtic fluids, in 1766.

He eſtabliſhed a new theory of putrefaction and the antiputreſcents, and attributed the firſt to the diſengagement of fixed air or the carbonic acid and the reſtoration of the putrid matters to the reſtitution of this principle. Though this theory has been diſcovered to be erroneous, ſince it has been known that the carbonic acid is not contained ready formed in the animal ſubſtances, and that it acts only as acid, not as principle of theſe ſubſtances in its antiputreſcent energy, yet the efforts of this able chemiſt have conducted us to new and uſeful conſiderations upon this ſpontaneous motion.

Boiſſieu, Bordenave and Godart, in three Memoirs which gained the prize and the acceſſit propoſed upon putrefaction in 1767, by the Acadamy of Dijon, have alſo given uſeful obſervations upon this natural alteration, and have eſtabliſhed the baſis of doctrine for determining its cauſe, phenomena and reſults.

Finally, the labours of the moderns, eſpecially Citizen Berthollet, and the data afforded by the pneumatic doctrine threw a new light upon this kind of fermentation and furniſhed a more exact explanation of its circumſtances and products.

3. A firſt fact which muſt be inſiſted on, relative to putrefaction, is the extreme facility with which it eſtabliſhes itſelf, and the rapidity with which it goes through its periods in the animal ſubſtances: the cauſe of this ſtrong tendency, which is not found in the immediate materials of

plants, neceſſarily depends upon the difference of nature which diſtinguiſhes thoſe two claſſes of organic compounds. It has been ſeen in all the preceding articles, that the animal compoſition differs from vegetation by a greater number of conſtituent principles, and by the proportion of theſe and the principles that are common to both. The azote added to the hidrogen, the carbon, and the oxigen, the ſuperabundance of the hidrogen in the animal compounds, the phoſphorus and ſulphur which are very frequently combined with theſe firſt principles, complicate their production and are the ſource of the more numerous and more varied products which are obtained from them by the different agents to which they are expoſed. The multiplied attractions which exiſt between their more numerous conſtituent elements render their equilibrium more eaſy to be deſtroyed, and induce at the ſlighteſt variation of circumſtances, a decompoſition, or change of nature, which quickly gives riſe to other products more varied than are obtained from the vegetable ſubſtances. Life ſupports and maintains with more or leſs force this equilibrium, this permanency of ſtate, and it is in this that it conſiſts; but death permits the firſt principles to re-act in particular the one upon the other. This ſpontaneous re-action muſt then be more prompt, more profound and more effective, as it takes place amongſt ſubſtances more numerous, and by virtue of attractions more multiplied;

plied: it is therefore eſſential to the animal matters to be more putreſcible than the vegetable.

4. As whatever belongs to putrefaction preſents a great intereſt to the ſcience and to its numerous applications, the hiſtory of this alteration requires to be exhibited with a method ſufficiently ſtrict to omit nothing eſſential, to place every fact, every truth in the ſuitable light, to give to each the evidence and the force which belong to it, and to form of all a collective whole: I ſhall therefore treat ſucceſſively and in a ſeries of numbers;

A. Of the preliminary conditions of putrefaction;

B. Of the general phenomena which accompany it;

C. Of the exiſtence of particular phenomena which may ſerve to characterize each animal matter;

D. Of the influence which the different media have upon it;

E. Of the different products to which it gives riſe;

F. Of the laſt reſiduum which it leaves;

G. Of the cauſes which determine it; of its nature, and of the principles in which it conſiſts;

H. Of its effects upon the living animals;

I. Of the means of remedying it;

K. Of thoſe of preventing it;

L. Of thoſe of ſtopping it, or of the antiſceptics;

M. Of the principal applications which all theſe facts offer to medicine ;

N. Of the products which men have derived from it for their wants.

Each of theſe ſubjects requires only a mere ſketch, as the preſent object is only to connect them with what has hitherto been ſet forth concerning the general characters of the animal matters, to derive from them a general notion concerning their chemical properties ; and as beſides the generalities, new details will be given in the hiſtory of each animal matter in particular.

5. Though the abſence of life has already been announced at leaſt as a condition eſſential to putrefaction, as the energy and the power of the vital principle actually oppoſes this motion its exiſtence is admitted only when this energy is weakened, and in ſome particular caſes.

Death is not the only condition neceſſary to putrefaction ; there is alſo required the combination of ſeveral other circumſtances without which it would not take place. Theſe may be reduced to moiſture and moderate heat. It is proved by a great number of facts that the dry animal matters do not putrefy ; the bones, dried meat, and anatomical preparations keep without alteration ; bones ſoftened by water, the ſoft fleſh, and eſpecially the animal liquids, paſs on the contrary rapidly into putrefaction : it even principally follows the proportion of the quantity of water which exiſts in the animal ſubſtances. It is no leſs aſcertained that there can be no putreſcence at the freezing temperature and below it; but that the ſeptic alteration commences at ſix or eight degrees above it; and proceeds in a progreſſion the more rapid, as the temperature of the ſubſtances which experience it is more elevated. This condition, however, has its limits; heat near the temperature of ebullition, and even that which exceeds from 45 to 50 degrees of Reaumur's ſcale, no more permits putrefaction than the cold; it even defends the animal ſubſtances againſt this motion, as it tends, either to dry them, or to condenſe their texture or coagulate their maſs, or to decompoſe them in another manner. The proportion of the elements which here act as conditions of putrefaction produce ſome modifications in it; water accellerates it by its quantity; the abundance of caloric ſometimes joins the effects of partial volatilization with thoſe of the putrid decompoſition. It was long believed that the contact of the air was neceſſary to putrefaction; but it is certain that as it takes place in a vacuum, and in ſmall proportions of air not renovated, the contact of the latter is only a condition which accelerates the putreſcence, not by the influence which it exerts of itſelf upon the animal ſubſtances, but merely by ſerving as a recipient for diſſolving and carrying off the materials that raiſe themſelves in vapour. It is to the ſame claſs that we muſt refer the diminution of preſſure, which ſome authors have conſidered as one of the cauſes of putrefaction: we ought not to omit amongſt the conditions of putrefaction the admixture of fermented matters, and eſpecially of thoſe that are putrefied with the freſh ſubſtances: this ferment acts by raiſing the maſs, and accelerates and develops the putrefactive motion.

6. When the conditions of putrefaction, namely, an animal ſubſtance deprived of life, moiſt and expoſed to a temperature above 10 degrees, are combined, this motion eſtabliſhes itſelf; the animal ſubſtance ſoftens if it was ſolid, or becomes thinner if liquid; its colour changes, and inclines more or leſs towards the red-brown, or the dark-green; its odour is altered, and after having been at firſt faint and diſagreeable, it becomes fetid and inſupportable. An ammoniacal ſmell ſoon mixes with the firſt, and deprives it of part of its fetidity: this is only temporary, whilſt the putrid odour exiſting before it, ſtill remains after it and ſubſiſts during all the phaſes of the putrefaction. The liquids become turbid and filled with flakes; the ſoft parts are melted into a kind of jelly or putrilage; there is obſerved a ſlow motion, a ſlight inflation which raiſes the maſs, and which proceeds from bubbles of elaſtic fluids, diſengaged ſlowly and in ſmall quantities at a time. Beſides the general ſoftening there runs out a ſeroſity of different colour which conſtantly augments; gradually the whole maſs melts, this ſlight inflation ceaſes; the matter ſinks, the colour grows darker; at length the ſmell becomes frequently

as it were aromatic and approaches even to that which is termed *ambroſiacal;* finally the animal ſubſtance diminiſhes in maſs, its elements evaporate and diſſolve, and there remains nothing more than a ſort of fat, viſcous earth, ſtill fetid.

The duration of this putrid decompoſition, though varied, preſents four very diſtinct periods which Boiſſieu has carefully diſtinguiſhed: the firſt, or that of the *tendency* to putrefaction, exhibits an alteration that is ſtill but ſlight; it preſents only the muſty ſmell, the ſoftening of the ſubſtance and a ſlight change of colour; the ſecond, or the *commencing* putrefaction, ſometimes affords ſigns of acidity: the ſoftening is more conſiderable; the ſeroſity begins to eſcape from the relaxed fibres; the colour is more altered and the fetid odour already putrid. In the third degree of the *advanced* putrefaction, the odour which is always fetid, is more or leſs ammoniacal; the matter diſſolved into putrilage is of a dark colour; it has loſt much of its weight by the diſengagement of a large quantity of volatile principles. The laſt degree, or the *accompliſhed* putrefaction, no longer preſents the ammoniacal odour; the fetidity is ſupportable, ſlight or none at all; an aromatic odour frequently ſucceeds in the place of it; the animal matter has loſt a great part of its volume and all appearance of organization; there remains nothing more than an earthy reſiduum, of a blackiſh-brown colour, fat to the feel, which in this ſtate is called *animal mould.*

7. Theſe phenomena vary according to the different animal matters; the difference of their nature and the different proportion of their principles are the ſource of them. It may even be ſaid that each animal ſubſtance has its different manner of comporting itſelf in putrefying. Hence, all the varied and diverſified ſcenes, which have been deſcribed by different authors, and of which we find a faithful account, both in the ſingular work of the phyſician Garman, entitled *De miraculis mortuorum,* in which are detailed the ſlow and ſucceſſive changes of all the parts of the human body in the cemeteries, and in the *Eſſay on putrefaction* by Madame Darconville. But as this object belongs to the hiſtory of each animal ſubſtance conſidered in particular, I mention it here only in order to eſtabliſh the principle of this variability of phenomena: it ſhall be treated of in each of the ſubſequent articles.

8. It is alſo a variation independent of the animal matter, and ſubjected only to that of the ſurrounding bodies, which I muſt here conſider in general under the title of the influence of the media in putrefaction. The ſingle obſervation drawn from the different cuſtoms of nations with reſpect to their dead, or from the poſition of the carcaſes of animals placed in different circumſtances, according to the places in which they ar deprived of life, ſufficiently

proves this remarkable variation. The bodies are ſeen altered in a different manner amongſt the nations of the South Sea, who expoſe their dead in the air, upon elevated places, in the cabins of boughs of trees of their morais, upon the ſummits of trees; amongſt the nations who immerſe them in the water; and amongſt the more poliſhed nations who immerſe them in the earth. I have ſaid elſewhere that the animal parts placed in water are converted there into fatty ſubſtance; an alteration nearly ſimilar takes place in moiſt earth: but the greateſt difference which is of importance to be conſidered here, is that which takes place in the air, relatively to the phenomena which accompany putrefaction in cloſe veſſels. I have ſuppoſed this latter circumſtance in deſcribing (No. 6) the general phenomena of the putrid alteration. In the air, a portion of the entire animal ſubſtance is carried away and diſſolved by the atmoſphere; the products which are volatilized are equally carried away and diſſolved by the air. The total and complete deſtruction of the animal ſubſtance is effected with more or leſs rapidity. All the events of this decompoſition are much nearer to one another, as the exterior agents contribute to ſeparate the elements of the matters which putrefy. Here the animal matter at laſt completely diſappears, ſince after what the air receives of volatile principles, the ſmall quantity of earthy reſiduum which eſcapes this aëriform ſolution penetrates gradually into the earth, where it is buried and carried away by the filtration of the waters.

9. Though we may rank amongſt the phenomena of putrefaction, the matters which are diſengaged from the putreſcent animal ſubſtances, I ſhall conſider them here in particular as products, becauſe they proceed from the action of this motion itſelf, and becauſe it is important to know them with more accuracy and preciſion than the mere inſpection or even obſervation of theſe phenomena would permit. In order to determine the nature of theſe phenomena, to follow with attention the ſeries and the epochas of their diſengagement, and conſequently to know in what the decompoſition of the animal matter conſiſts, it was neceſſary that a conſecutive analyſis of the putrid vapours, an attentive examination of the putrefied matters, ſhould ſupply the place of the theory which had attempted to divine their characters. Thus it was long believed that the ammonia or volatile alkali was the ſole product of putrefaction, and it was on this account that it had been called *alkaline fermentation*, in oppoſition to that which gives riſe to the acetous acid: but though ammonia is indeed one of the principal products of this ſpontaneous motion, it is not the only one; there are others, the production of which precedes, accompanies, or follows its production, and which deſerve to be known and ſtudied with equal attention. There are even ſome

animal matters the ſeptic decompoſition of which commences with an acidification.

We ſhould have only an imperfect and ſuperficial notion of theſe products, if, after being aſſured that they are not the ſame nor in the ſame proportions with the different animal matters, we did not endeavour to approximate all theſe various products, to collect under a ſingle point of view all the ſubſtances afforded in the putrefaction of the different animal compounds, and thereby embrace the totality of theſe products.

It is then found that the animal ſubſtance ſucceſſively gives riſe, in its putrid decompoſition, to carbonated, ſulphurated, and phoſphorated hidrogen gaſes, which carry and propagate its infection far and wide; to water, which is diſengaged in vapour, to ammonia, and to carbonic acid gas. All theſe bodies eſcape, are diſſipated and volatilized; they carry off with them combined two and two together, the principal primitive materials of the animal compound. Other products, formed at various periods, as acceſſary circumſtances of the compoſition of each animal matter, differ from the preceding by their fixity, and remain in this matter more or leſs ſolid and fixed: ſuch are the zoonic acid, a fat matter, a kind of ſoap formed by this fat and ammonia; ſuch is alſo the nitric acid, frequently formed in this decompoſition, and fixed by an earthy or alkaline baſe; ſuch finally is the unctuous mould which remains after the ſeparation

tion and the diſengagement of the preceding products. Thus the animal matter is gradually ſeparated, divided and deſtroyed: we ſhall ſoon ſee how theſe products are formed and ſucceed each other.

10. It is eſpecially uſeful to diſtinguiſh, amongſt the products of the putrefactive motion, that which is its laſt reſult, that which, after the diſengagement of all the volatile materials, remains fixed, and conſtitutes the reſiduum. Its ſmall quantity, its contracted volume, its earthy form very remote from organization, of which it preſents nothing more than the wrecks or the moſt ſolid matter, have at all times fixed the attention of the philoſopher. The remains of a large maſs of organized matters, of which it forms only ſome hundredth parts, it has long been conſidered as a particular earth, which was diſtinguiſhed by the name of animal earth. But this denomination, derived from its pulverulent ſtate, its inſipidity, its inodorous quality, as well as its fixity and inſolubility, is inaccurate and erroneous, ſince this reſiduum, this animal mould, contains, beſides the acids and the earths combined in the ſaline ſtate, a portion of fat coally matter, which, when diſtilled, ſtill yields oil, carbonate of ammonia, and leaves a coal charged with earthy phoſphates. The fixed, ſaline, earthy and metallic matters which conſtitute the nature of this reſiduum, retain for a long time a portion of oily ſubſtance more or leſs concrete, which is deſtroyed only very ſlowly;

and in order that they may be reduced to the pure ſaline and earthy ſtate, analogous to the aſhes which remain after combuſtion, it almoſt always requires a long ſeries of years. Thus carcaſes buried in the earth are not reduced to their dry ſkeleton, and do not loſe the laſt remains of their ſoft parts, till after a lapſe of time, which generally exceeds ſeven years, and which is ſometimes prolonged to more than thirty. The excavations in the ground of the cimetery of the Innocents at Paris have proved this to me in an inconteſtible manner; it is eaſily conceived that the proportion and the nature of this reſiduum correſpond entirely with thoſe of the fixed matters, which formed conſtituent parts of the animal compounds, and that they muſt vary according to each of theſe compounds.

11. As we have now ſeen the conditions of putrefaction, the phenomena which it preſents to the obſerver, the general influence which it receives from the mediums in which it acts, the different products which it affords, and the reſiduum which it leaves, it is time to occupy ourſelves with its intimate nature. It is not enough to have conſidered it as a ſlow decompoſition, as a ſpontaneous analyſis, as a deſtructive fermentation of the organic compounds, becauſe it has all the characters of the inteſtine motions which are deſignated by this name in chemiſtry; it is neceſſary that we ſhould penetrate more intimately into its cauſe, to aſcertain and explain its mechaniſm. It is evident that it conſiſts in

a change effected by a ſum of attractive forces ſuperior to thoſe which keep the principles of the putreſcent ſubſtance united. Theſe principles are, as we know, hidrogen, azote, carbon and oxigen, with which are frequently aſſociated ſulphur, phoſphorus, and different kinds of phoſphates.

It is evident that, in putrefaction, part of the hidrogen unites with the azote to form ammonia; another part of the hidrogen combines with a portion of oxigen with which it conſtitutes water; that a certain quantity of carbon, combined with a relative quantity of oxigen, gives riſe to carbonic acid; that a portion of azote united with a third quantity of oxigen produces nitric acid; that a combination of hidrogen, carbon and azote forms the volatile or the fixed oil, according to the proportion of theſe principles; that another combination between the ſame matters and oxigen compoſes the zoonic acid; and that finally, the ſaline, earthy, and metallic ſubſtances, being unalterable, or little alterable by the inteſtine motion of putrefaction, remain untouched and paſſive in the laſt reſidue of this ſpontaneous motion, carried to its *maximum*.

It is no leſs evident that theſe matters or new compounds, which did not exiſt originally in the animal ſubſtances, unite two and two together, the ammonia and the carbonic acid, the ammonia and the zoonic acid, the ammonia and the oil which it reduces to the ſaponaceous ſtate, and are diſengaged in this form in the air, or diſſolved in the water. All theſe new compoſitions, which are leſs complex than the primitive compound which gives riſe to them, and which are the products of its ſlow diſſolution and the indications of its deſtruction, are the conſequence of numerous attractions which act amongſt the multiplied principles of the organic compound deprived of life.

We may comprehend in a general formula the totality of all theſe attractions, and expreſs with preciſion what takes place in putrefaction, by ſaying that the ſum of the forces which tend to unite the hidrogen with the azote, the oxigen with the carbon, the carbonic acid with the ammonia to form the ammoniacal carbonate, and the hidrogen, the carbon, and the oxigen to produce oil; this latter with the ammonia to conſtitute a ſoap; and finally, the hidrogen with the oxigen to produce water, and the latter with all the preceding compounds,—that this whole ſum is ſuperior to the ſum of the forces which retain in quaternary combination the hidrogen, the azote, the carbon and the oxigen, to conſtitute the animal compound.

We have here repreſented only the alterant action of theſe forces, and the putrefactive effect which reſults from them in cloſe veſſels, into which nothing extraneous to the organic ſubſtance can enter, and from which nothing can eſcape; for though the reſults are ultimately identic, they take place in a very different manner in the midſt of the atmoſpheric air. In the latter circumſtance, a part of the animal ſubſtance is diſſolved and carried off conjointly and ſeparately by the air and by the water; the ammonia and the carbonic acid are volatilized as faſt as they are formed; a portion of carbonated hidrogen is volatilized by the alteration of temperature: and there is formed neither fat matter nor ammoniacal ſoap.

Thus may be explained in a ſimple manner the phenomena and the products of putrefaction; and thus its conditions, its varieties, its duration, &c. may be comprehended. It was natural to conſider them as inexplicable, as long as the nature of its products, that of the water, of the ammonia, of the oils, and of the acids, were involved in an obſcurity which neceſſarily extended itſelf over the progreſs and the mechaniſm of this kind of fermentation. This obſcurity has, as we ſee, been diſpelled by the efforts of the pneumatic chemiſtry which has left nothing unintelligible in the knowledge of this ſpontaneous decompoſition. This is one of the fruits which we owe to its progreſs and its happy revolution.

12. Amongſt the phenomena dependant upon putrefaction which it is of importance to conſider, muſt be reckoned the dangerous effects which it produces upon living animals. If we except a very ſmall number, belonging to the laſt claſſes of theſe beings and endowed with the leaſt ſenſibility, there are none which an animal matter in the ſtate of putrefaction does not deter

and repel from the place where this ſcene of death and deſtruction is exhibited. By the diſguſt with which it inſpires them, by the haſty flight which it occaſions, it is eaſily conceived that this phenomenon is inimical to life, and that it threatens it with remarkable energy. Accordingly, the greater number of animals cannot feed upon animal matters putrefied to a certain degree; and though ſome of them, being indolent and ferocious at the ſame time, devour carcaſes already tainted, none make them their food when the putreſcence is too far advanced. We know the averſion and diſguſt which all mankind have againſt corrupted animal matters, the diſagreeable effect which they produce upon their organs, and the repugnance which their ſenſe of ſight and ſmell experience at the mere aſpect of theſe matters. Frequently the putrid miaſmata or the gaſes which are exhaled from bodies in the ſtate of putrefaction, are ſo deleterious, that men and animals are deprived of ſenſe by their contact. When they do not produce this ſudden effect, they occaſion putrid diſeaſes in ſuch as are expoſed to them. Some individuals contract external affections, carbuncles, malignant and gangrenous puſtules by the corruptive action of theſe vapours; others are influenced by them in a much more dangerous manner, for beſides a conſiderable proſtration of the powers of life, they become affected with putrid fevers of the moſt malignant character. It is not yet known what is the nature of the putrid gas from which theſe terrible effects ariſe: it is not the azotic gas, as ſome modern phyſicians have thought, who on that account have given it the name of *ſepton* or rather *ſeptic gas*. There is reaſon to ſuſpect that they ought rather to be attributed to the action of the putrefied animal matter itſelf, which being diſſolved in the gaſes exhaled during its putrefaction, carries into the organs which are the focus of life its benumbing or debilitating principle, and pours into the torrent of the animal humors the putrid germe or ferment, which they are unfortunately ſo much diſpoſed to receive.

13. Science, whilſt it enables us to aſcertain the ſource and the cauſe of theſe terrible effects, furniſhes us with arms for preventing or determining its influence. Two means preſent themſelves, ſuggeſted by reaſon and confirmed by experience: the one, which belongs to the police and the wiſdom of government, conſiſts in removing from populous places, particularly from large towns where the accumulation and crowded ſituation of the inhabitants is already a pre-diſpoſing cauſe of putrid diſeaſes, the ſources of infection and putrefaction. To aërate the habitations, to eſtabliſh a frequent ventilation in them, to cover the common ſewers, to remove ſinks of all kinds, to eſtabliſh burial places out of the towns, to kindle large wood-fires in ſuch ſituations that the wind may carry the ſmoke into the places which we wiſh to preſerve, to obtain a profu-

ſion of freſh and running water in open canals, and eſpecially to cauſe it to aſcend in fountains or precipitate itſelf in caſcades; theſe are the grand means of preventing putrefaction or at leaſt of repelling its invaſions. The other means, more confined in its application, and practicable only in ſmall ſpaces or in circumſcribed places, has for its object to deſtroy the putrid miaſmata themſelves, to fetter their activity, and to neutralize their virulence. This effect is obtained by the diſengagement of the muriatic acid in gas, and eſpecially by the oxigenated muriatic acid, which I conſider, and which I propoſed ſome years ago, as the greateſt external antiſeptic, becauſe it attacks and deſtroys the animal combination which conſtitutes the virus. Its advantages and uſe in this point of view will be the better underſtood, in proportion as the principles of chemiſtry ſhall be diffuſed in the work-ſhops and become familiar to manufacturers and artiſts.

14. Art has always ſought the means of preventing the putrefaction of animal matters, and defending them againſt corruption. The number of means and matters of this kind which it has diſcovered is very conſiderable; the principal are, as is eaſily conceived, all the proceſſes which deſtroy the conditions that give riſe to it. Thus the deſiccation of animal matters, the privation of water, refrigeration, or preſſure, are the firſt and moſt certain, becauſe by their ſimple influence, they make

the cauſes diſappear which develope putrefaction. Many ſubſtances with which the animal matters are enveloped or which penetrate their texture anſwer the ſame purpoſe. The acids, the ſalts, the aromatics, ſugar, the fixed and volatile oils, the reſins, camphor, the powder of dry and odorous plants, of acrid reſinous bitter woods; charcoal, generous wines, alcohol; the bitumens; particularly poſſeſs this property: accordingly, theſe are the ſubſtances which are employed with the moſt ſecurity for preſerving animal matters in the art of embalming, ſalting, in condiments, macerations in vinegar, &c.

15 Medicine has been occupied with a particular intereſt in the reſearch of ſubſtances capable of retarding or ſtopping the progreſs of putrefaction which frequently manifeſts itſelf in ſome parts of the diſeaſed human body; it has called them *antiputreſcents* or *antiſceptics*. On comparing them with thoſe already indicated we find great analogies between them.

Godart obſerves that all the poſſible antiſeptics may be reduced to three claſſes:

A. The refrigerants, which comprehend all the means of diminiſhing heat, the great influence of which upon putrefaction we already know. He ranks in this claſs: cold, the aqueous ſubſtances, the farinaceous matters, the acids, and the ſedative.

B. The ventilants or thoſe which diſſipate the putrid miaſmata, are the agitation of the air, the evacuents, the cordials;

C. The corroborants, which condenſe or contract; amongſt which he enumerates the acerb, the aſtringent, and the bitter ſubſtances.

Bordenave has referred the medicinal antiſeptics to ſix claſſes; namely, the antirelaxants, the ſtimulants, the aſtringents, the balſamics, the deſiccants and the cauſtics.

Boſſieux, in a very extenſive and very methodical table, has preſented their ſeries diſtributed into a great number of ingenious diviſions, which it is not my object here to exhibit. In all the conſiderations relative to theſe agents, there have eſpecially been diſtinguiſhed the ſulphuric acid, the carbonic acid, the vegetable acids, the Peruvian bark, Scorduim, Guaiacum-wood, camphor, tannin, the gall-nut, alcohol, the metallic ſalts and their ſolutions: ſome have even gone ſo far as to pretend to reſtore fleſh already in a very advanced ſtate of putrefaction to its original condition. Macbride has more eſpecially attributed this effect to carbonic acid, becauſe putrified fleſh immerſed in it reſumes a part of its colour and conſiſtence: but it is very evident that this is an exaggerated pretenſion, and that nothing more has been effected than the ſeparation of the exterior part, the moſt advanced in putrefaction, from the ſtill ſound portion; for ſcience teaches us that it is impoſſible to form anew an animal matter that has been deſtroyed, and that we cannot in this reſpect ſurpaſs Nature, who herſelf is ſubjected to the impoſſibility of making a retrogade ſtep in this putrefaction.

16. After all the preceding conſiderations, it cannot be doubted that putrefaction is a ſlow decompoſition, a kind of ſpontaneous analyſis effected by virtue of complicated attractions, exiſting between the numerous principles of the animal matters, namely, the hidrogen, the azote, the carbon, the oxigen, the ſulphur, and the phoſphorus; that the motion, which is excited amongſt theſe principles, and which has great analogy with a fermentation, (whatever Boerhaave and his ſchool may ſay of it, who did not admit of this analogy) is in ſome meaſure ordained or willed by Nature; that it is the means which ſhe employs in order to deſtroy the animal organization and compoſition, when the animal matters, deprived of life, can no longer ſerve in the animated form, for the exerciſe and ſupport of which thoſe primitive matters had only been lent them according to the immutable laws eſtabliſhed in the order of the univerſe; that Nature thus takes back thoſe principles, which are no longer employed in the phenomena of life, and reſtores to other more ſimple combinations the portion of matter which conſtituted the bodies of the animals. Thus, by the admirable order which exiſts in the economy of Nature, the moſt complicated phenomena which repreſent during life the maſter-piece of organization and the moſt numerous chemical phenomena,

are reduced after death into more ſimple compounds, almoſt all binary,—and by the aid of the putrid decompoſition, return into the claſs of the minerals, are thus reduced almoſt to the ſtate of elements, are diſſolved in the water, diffuſed in the earth, and ſerve for new combinations. Thus in ſtudying the properties and chemical characters of animal ſubſtances, we are led back to the ſimple and primitive ſubſtances with which we commenced the ſtudy of the natural ſubſtances. This effect, this tranſition, this circulation of ſubſtances, which had long ago been diſcerned by the ingenious Becher, were called by this chemiſt the circle of the eternal motion, *circulus æterni motus.*

17. Men have at all times availed themſelves of the phenomena and products of putrefaction, and have in ſome ſort derived the ſupport of their exiſtence from the very womb of death and deſtruction. The animal matters corrupted and reduced to the ſtate of mould are employed with much advantage as manures; in order to diminiſh their too hot and too nouriſhing properties, they are not diſtributed in the ground which is intended to be manured, until they are almoſt entirely deſtroyed. They are ſometimes alſo prepared by particular proceſſes of deſiccation and concentration, as is done in the vicinity of Paris with the filth of the privies, in order to convert it into a dry and very fecundating powder, which is called *poudrette.* In other places, by cauſing the animal matter to putrefy with

vegetable ſubſtances, or by moiſtening the latter, depoſited in dry layers and expoſed to decompoſition under ſheds with animal liquids, urine, the waters of kitchens, of ſhambles, &c. the production of nitre is accelerated, by means of the azote which thoſe liquids afford. In ſome manufactories animal ſubſtances, and eſpecially corrupted urine is employed for extracting with facility very abundant quantities of carbonate of ammonia. Laſtly, we might avail ourſelves of the diſcovery which I have made of the converſion of the bodies of animals into fat in ſtagnant waters or in moiſt earth, in order to prepare with offals that hitherto have been applied to no uſe, fats which would be uſeful in a great number of the arts. We are even aſſured that Engliſh induſtry has already availed itſelf of this diſcovery, and that a concrete oil is prepared in England by this mode of putrefaction.

18. There are ſome circumſtances which, by oppoſing more or leſs powerfully the putrid decompoſition of the animal matters, leave them only the poſſibility of being converted into ſubſtances of a different nature, and ſuſceptible of keeping for a long time in this ſtate. In this claſs are to be ranked; 1. dead bodies deſiccated by a dry and glowing atmoſphere, or by an arid and violently heated ſand; 2. the natural mummies, and the mummies which art, at the ſuggeſtion of a religious ſentiment, or of a reſpectful attachment to the remains of beloved objects,

prepares by the aid of all the preſervative means and embalment; 3. bodies and their organs prepared by different anatomical means; 4. hair, ſilk, feathers, ſkins, prepared and preſerved in ſolid and durable textures; 5. ſmoaked, ſalted fleſh, which has become hard and as it were of a woody conſiſtence, in which ſtate it keeps for a long time without alteration; 6. bones, horn, ſcales, dried and converted into utenſils or machines of various forms and various utility; 7. bones impregnated with different minerals in the boſom of the earth, and eſpecially thoſe which are converted into turquoiſe. There is alſo reaſon to believe that a portion of the remains of animal ſubſtances, ſo abundant in the water of the ſea, and of large rivers, enters by their more or leſs advanced decompoſition, and by aſſuming the character of oily matter, into the formation of the bitumens. As to the petrified animal ſubſtances, which are generally ranked in the ſame ſeries with the preceding ſubſtances, theſe are either ſolids impregnated with calcareous diſpoſition, or merely moulds filled with ſiliceous matter.

THIRD ORDER OF FACTS

OF THE PROPERTIES OF PARTICULAR ANIMAL SUBSTANCES.

ARTICLE I.

Of the Compariſon and the Claſſification of the different Animal Subſtances.

SECTION I.

Of the different Modes of their Claſſification.

1. IT is not ſufficient to have conſidered the animal ſubſtances in general, and inveſtigated the characters which diſtinguiſh them from the vegetable matters. This firſt inquiry ought only to be conſidered as an introduction to the hiſtory of theſe ſubſtances in particular. It ought to precede and to elucidate it; but it cannot be ſubſtituted in place of it; it has only the advantage of rendering more intelligible the examination of their properties, and diminiſhing the extent of the details which this examination would have required, if the expoſition of the general properties of the animal matters had not determined their nature.

2. Though it may appear, at the firſt glance, a matter of indifference whether the chemical

hiſtory of the animal matters be treated in ſuch or ſuch an order, it is however neceſſary to decide in the choice of this order, and on this account it becomes neceſſary to indicate and compare with each other the different methods of claſſifying theſe ſubſtances. We know in the firſt place that they may be conſidered as a kind of immediate materials of animals, and that in this point of view it would be poſſible to divide or rather diſtribute them, as has been done with reſpect to theſe vegetable matters, into ſuch as are ſoluble in water, into oily, ſaline, ſolid and inſoluble ſubſtances. But this firſt kind of diviſion is very imperfect and very inaccurate, as it is far from comprehending all the ſubſtances which compoſe the bodies of animals.

3. The diviſion of theſe ſubſtances into liquids and ſolids is alſo inſufficient. Frequently the works on chemiſtry have followed the diviſion into recrementitious liquids, ſuch as the blood, the lymph; excrementitious, ſuch as the urine, &c. and excremento-recrementitious, as the bile, the ſperm, &c. We have no greater reaſon to be ſatisfied with this claſſification, which preſents nothing well fixed and accurate. Theſe matters might be arranged, according to their chemical nature, into four claſſes, according to the ſuperabundance of one or other of the principles which enter into their compoſition. Thus we ſhould have:

A. Hidrogenated or oily animal ſubſtances; ſuch as the fat, the cerumen, the bile.

B. Oxigenated animal ſubſtances or oxides; the albumen, the lymph; in theſe would be comprehended the lymph, the water of the interior cavities, the cerebral pulp.

C. Carbonated animal ſubſtances; the gelatinous or mucous, comprehending the membranes, the aponeuroſes, the tendons.

D. The *azotated* animal ſubſtances, fibrous or fleſhy; ſuch as the muſcles, certain viſceral parenchymata.

E. The *acid* animal ſubſtances; the uric acid, the formic acid, the bombic, &c.

F. The *ſaline* aqueous animal ſubſtances; as the aqueous and the vitreous humor, the tears, the ſaliva.

G. The *phoſphated* animal ſubſtances, eſpecially thoſe in which the phoſphate of lime predominates; in this claſs would be placed the nails, the horns, the hair, the bones.

H. Finally, the *mixed* animal ſubſtances, containing ſeveral of the preceding materials; this laſt claſs would belong to the blood, the milk, the ſperm, the urine.

4. The chemical method which I have juſt ſketched would be beyond all contradiction the moſt perfect, the moſt exact, and that which ought to be preferred to all others, if the animal analyſis were more advanced, and if the comparative nature of the animal liquids and ſolids were better known. For not to mention that all theſe matters have not yet been ſufficiently analyzed to enable us to rank them in one or other of the eight claſſes

7. The third claſs of animal matters comprehends thoſe which are peculiar to ſome orders of animals, and which are frequently employed in the arts; and as theſe orders are ſeven in number, it is divided in the ſame manner.

The firſt diviſion contains thoſe which are particularly furniſhed by the mammalia, ſuch as ivory, hart's horn, horn, wool, muſk, civet, ambergreaſe and the bezoars.

The ſecond diviſion is reſerved for thoſe which are obtained from the birds; namely, the eggs, the feathers, the dung, and the membrane of the ſtomach.

The third preſents the product particular to the amphibia, the viper and its poiſon, the ſkinc, the lizard, the toad, the tortoiſe and its ſhell.

The fourth is appropriated to ſome productions peculiar to fiſhes, iſing-glaſs, fiſh-oil, the ſcales of the blay, and the bones of the head of ſeveral of theſe animals.

To the fifth I refer ſome matters belonging to the teſtacous fiſh; the bones and the ink of the cuttle fiſh, pearl and mother of pearl ſhells.

In the ſixth I place thoſe which are extracted from inſects and worms, the honey and the wax of bees, cantharides, wood-lice, ants, their acid and lac, the bread of the ant, ſilk, cochineal, kermes, crab's eyes, the lumbrici.

Finally, the order of Zoophytes affords four particular animal matters; namely, coralline, coral, the madrepore, and the ſponge.

8. In order to exhibit the collective whole of this diviſion of the animal ſubſtances, I here preſent a table in which the relation, the difference and the claſſification will appear at the firſt glance. It will there be ſeen that there are fifty-three different ſubſtances in the two firſt claſſes, and forty-one in the third; the importance of the fifty-three firſt obliges me to treat of them in a pretty conſiderable number of ſeparate articles. As to thoſe of the third, which preſent more or leſs reſemblance with thoſe of the two firſt claſſes, I ſhall content myſelf with giving an account of them in the ſeven articles which will comprehend the particular products formed by the ſeven orders of animals.

TABLE

Containing the Diviſion and the Claſſification of the Animal Matters.

All the Animal Matters, conſidered in their mutual relations, may be divided into the three following Claſſes.

FIRST CLASS.

Animal Matters belonging to the whole Body.

Liquids,	Blood,	1
	Lymph,	2
	Fat,	3
	Tranſpiration,	4
	Humor of the internal cavities,	5
	Synovia,	6

Soft parts.	Cellular texture,	7
	Membranous texture,	8
	Tendinous texture,	9
	Aponeurotic texture,	10
	Ligamentous texture,	11
	Glandular texture,	12
	Muſcular texture,	13
	Cutaneous texture,	14
	Epidermoid texture,	15
Solids.	Hair,	16
	Cartilage,	17
	Bone,	18

SECOND CLASS.

Animal Matters belonging to ſome particular Regions of the Body of Animals.

To the cranium.	Cerebral pulp,	19
	Nervous fluid,	20
	Liquor of the ventricles,	21
	Pineal concretions,	22
To the face.	Aqueous humor,	23
	Vitreous humor,	24
	Cryſtalline humor,	25
	Tears,	26
	Naſal Mucus,	27
	Mucus of the Mouth,	28
	Mucus of the tonſils,	29
	Saliva,	30
	Salivary calculi,	31
	Tartar of the Teeth,	32
	Cerumen,	33

To the thorax.	Tracheal and bronchial mucus,	34
	Gas of the lungs,	35
	Pulmonary concretions,	36
	Milk,	37
To the abdomen.	Gaſtric juice,	38
	Pancreatic juice,	39
	Bile,	40
	Biliary calculi,	41
	Inteſtinal juice,	42
	Chyle,	43
	Excrements,	44
	Gas of the inteſtines,	45
	Inteſtinal concretions,	46
	Liquor of the amnios,	47
	Superrenal liquor,	48
	Meconium,	49
	Urine,	50
	Urinary calculi,	51
	Juice of the proſtata,	52
	Sperm,	53

THIRD CLASS.

Animal Matters belonging to each of the Seven Orders of Animals in particular.

To the mammalia.	Ivory, - - -	54
	Hartſhorn, - -	55
	Horn, - - -	56
	Wool, - - -	57
	Muſk, - - -	58
	Civet, - - -	59
	Caſtor, - - -	60
	Ambergris, - -	61
	Spermaceti, - -	62
	Benzoar, - -	63
To the birds.	Eggs, - - -	64
	Feathers, - -	65
	Dung, - - -	66
	Membrane of the Stomach,	67
To the amphibia.	Viper, - - -	68
	Toad, - - -	69
	Skink, - -	70
	Lizard, - -	71
	Tortoiſe, - -	72
To the fiſhes.	Iſinglaſs, - - -	73
	Fiſh-oil, - - -	74
	Fiſh-ſcales, - -	75
	Fiſh-bones, - -	76

To

To the teſtacea.	Bones and ink of the cuttle-fiſh, - - -	77
	Pearl and mother of pearl,	78
	Shells, - - -	79
To the inſects and worms.	Honey and wax, -	80
	Cantharides, - -	81
	Wood-lice, - -	82
	Ants, - - -	83
	Lack, - - -	84
	Ant-bread, -	85
	Silk, - - -	86
	Cochineal, - -	87
	Kermes, - -	88
	Crabs'-eyes, - -	89
	Lumbrici, - -	90
To the zoophytes.	Coralline, - -	91
	Coral, - - -	92
	Madrepores, - -	93
	Sponges, - - -	94

ARTICLE II.

Of the Blood.

SECTION I.

Hiſtory and Analyſis of the Blood.

1. THE blood, this red and hot fluid contained in the arteries and the veins, neceſſary to life, moved inceſſantly by the circulation, moiſtening all the organs, conveying into them heat and motion, diſtributing nouriſhment, acting an important part in the animal economy, has always been conſidered as the principal object of the ſtudies and the reſearches of the anatomiſt, the phyſiologiſt, and the phyſician. The ſubject of many important inquiries, of a multitude of experiments, it is ſtill, notwithſtanding the ſtudies of the philoſophers and the numerous obſervations of the phyſicians, an inexplicable enigma; and though more advanced in the knowledge of its properties, modern phyſics are very far from the point at which they muſt arrive in order to explain its real influence upon the phenomena of life. Its effects appear to be extremely complicated, its uſes multiplied ad infinitum; we ſee it preſide in ſome meaſure over all the functions; reſpiration

tion acts eſpecially upon it; the circulation is performed in order to convey it to all parts of the body; it is this which warms the whole animal ſyſtem; it cauſes the heart to move; it is the common ſource of all the ſecretions; it nouriſhes all the organs; it affords the recrement as well as the excrement; it repairs the waſte of all the parts; the lymph is one of its productions; the tranſpiration eſcapes from the cutaneous extremities of the canals which tranſmit it; it exiſts every where, it vivifies all the organic ſyſtems, the totality of which conſtitutes the animal machine; it muſt therefore offer to the philoſopher the ſeries of all the problems preſented to him by the animal economy.

2. Accordingly the number of learned men who have occupied themſelves with it is immenſe: ſome have examined its chemical properties; its mere quantity, its weight, its motion have been the object of much inveſtigation, which is not even yet entirely terminated. Even its proportion is not known; and authors have varied amongſt themſelves from eight pounds to twenty-eight pounds for the quantity contained in the body of a man of the middle ſize. Some have ſaid that it forms a fifth of the weight of the body, others only a twentieth. Some reckon it at a ſixteenth, a fifteenth, &c. It is commonly believed to be diſtributed in ſuch a manner that the veins contain nine and the arteries four parts. When we read in the learned work on phyſiology by Haller, the opinions

of Harvey, Allen, King, Liſter, Drelincourt, Hales, Moor, Siegel, Primeroſe, Kiel, Lobb, Lower, Queſnay, F. Hoffmann, upon the proportion of the blood in the human body, we ſee how many difficulties and uncertainties attend the preciſe knowledge of its moſt ſimple properties. If we alſo remark in the ſame author what diverſity of opinion has prevailed in the ſchools concerning the difference of colour and temperature of the arterial and the venous blood, a queſtion which nevertheleſs ſeems eaſy to be ſolved by mere inſpection or by ſimple experiments; if we compare the celebrated names of Galen, Eraſiſtratus, Aretaeus, Harvey, Lower, Mayow, Schreiber, Willis, Swammerdam, Duverney, Verheyen, Helvetius, Michelotti, Lanciſi, Sevérini, Cheſelden, Hamburger, Martine, Pitcairn, Jurin, De Haen, who have not been able to ſolve theſe problems with accuracy, and who have left the reſult uncertain, notwithſtanding an aſſiduous labour of ſeveral ages: we ſhall be able to conceive with what fetters the human underſtanding has been ſhackled in its progreſs relative to this important part of phyſiology.

3. Hence, many able and learned phyſicians, deterred for a long time by this unſucceſsfulneſs of the phyſical ſciences, and not truſting more to the experiments of the chemiſts, have thought it neceſſary to take a different courſe in order to appreciate the properties of the blood. Founded upon the phenomena which it preſents in the living animals, they have con-

ſidered it as an aſſemblage of all the animal liquors, as a reſervoir of all thoſe materials, a ſolution of all the ſolid parts, a ſort of liquid fleſh, of plaſtic animal mucilage, hot, boiling, moved in torrents, tending to all parts of the body, communicating with all, aſſuming a particular nature in each organ and even in the vicinity of each of them, diſtributing into all their cells the materials which muſt ſerve for their reparation, remaining fluid only by the effect of motion, precipitating fibres already become ſolid by a ſlight agitation, diſpoſed to aſſume the ſtate of concrete maſs when its motion is retarded, animated by a particular or vital power which diſappears in death, and which can no longer be perceived in it when it is ſeparated from the living animals. This ſeries of notions they have called the medicinal analyſis of the blood. But whatever ingenuity Bordeu has diſplayed in the expoſition of theſe ideas, we find in them neither preciſion, nor accuracy, nor poſitive knowledge; but merely vague notions, the fruits of an active imagination, perhaps liable to the ſame reproach which he caſt upon the chemiſts.

4. Notwithſtanding the little confidence which the phyſicians (indeed amongſt thoſe who though otherwiſe poſſeſſed of much learning and talents had not acquired a ſufficient ſtock of chemical knowledge) have teſtified for the examination of the blood by the means of this ſcience, a great number of chemiſts, alſo belonging

ing to the claſs of the phyſicians, and conſequently competent to balance the opinion of the firſt, have occupied themſelves with the chemical analyſis of the blood.

After the firſt ſtill very inaccurate attempts of Barbatus and Bohnius in the ſeventeenth century, after the diſputes of Vieuſſens, of Willis, &c. whether to admit or reject the preſence of a pretended acid in the blood; Ruyſch treated experimentally the concreſcibility of the blood, the art of obtaining from it fibres, textures, membranes; Lewenhock and Hartſoeker inveſtigated its nature with the microſcope, and deſcribed in it a compound globulous ſtructure, of which Boerhaave has made an ingenious uſe, though it is nothing more than a ſort of microſcopic fiction.

Hales wrote learnedly upon its analyſis by fire, and upon the elaſtic fluid diſengaged from it by this agent.

Lemery found it to contain iron ready formed, the proportion of which was determined by Menghini.

Hoffmann was one of the firſt who deſcribed the chemical characters of its different parts ſeparated ſpontaneouſly.

Langriſh, Cheyne, Swencke, have given analyſes of it that are almoſt complete for the time in which they wrote.

Gaubius examined it after Boerhaave with much greater accuracy than his predeceſſor.

Rouelle the younger firſt ſhowed with preciſion the ſalts that are contained in it.

G. Hewſon deſcribed ſeveral of its properties with ſagacity.

Bucquet, immediately after Rouelle, particularly ſtudied the chemical characters of the coagulum and of the fibrous part.

Dehaen has ſhown that its coagulation, its ſerum, its buffy coat, vary according to the circumſtances of its extraction in veneſetion.

Cygna did all in his power to diſcover the cauſe of its rutilation by the air, which has ſince been placed out of doubt by the experiments of Lavoiſier, Menzies and Godwyn.

Crawford has determined the difference of the ſpecific heat of the arterial and of the venous blood.

Citizens Deyeux and Parmentier have examined with much attention the different materials of the blood, the ſerum, the fibre, the coagulum, and ſome of its morbid alterations.

I have likewiſe occupied myſelf with it, at different times during fifteen years paſt; I have aſcertained the preſence of the gelatin in it, the action of a violent fire in open veſſels, its difference in the fœtus, &c.

The rapid ſketch which I have juſt preſented is ſufficient to prove that much labour has been beſtowed upon the nature of the blood; I muſt terminate it by obſerving that though chemiſtry has not yet reſolved all the problems which this fluid preſents to it, it has at leaſt ſhown the path that muſt be followed in order to find their ſolution, as the following details will prove.

SECTION II.

Of the Entire Blood.

1. THE blood of man, and that of the bullock which much reſembles it, and which has been moſt frequently ſubjected to chemical analyſis, as it is procured with great facility, is a liquid of a beautiful purple-red colour, of a conſiſtence a little thick, gluey and viſcous, ſoft and, as it were, ſaponaceous to the touch, of a particular faint odour, and of a ſweetiſh and ſaline taſte. Its temperature is between 29 and 32 degrees centigrade. Phyſiologiſts have differed from each other with reſpect to the ſpecific gravity which they have attributed to it. They have found its relation to the gravity of water as 1053 or 1126 to 1000. It has been ſaid that, when viewed with the microſcope, it is a compound of red globules ſwimming in a tranſparent liquid, and that the red globules are formed of ſeveral other yellow globules united together; that theſe globules are divided and broken in the ſmall veſſels, and thus give riſe to liquids more and more pale, leſs and leſs coloured, which are found in the orders of veſſels more and more attenuated. Theſe globules were deſcribed as capable

of being compreſſed, elongated, flattening, and paſſing through the animal ſtrainers. Modern phyſiologiſts have rejected all theſe ideas as chemerical. What is true, ſays Haller in the hiſtory of theſe globules, is that we actually ſee ſuch in the blood with the aid of the microſcope; but the yellow ones which are alſo ſometimes ſeen in it are not ſmaller than the red, they are not diviſions of them, they appear only in debilitated animals; they ſwim in a tranſparent and almoſt inviſible ſerum; the red globules have neither been ſeen to break nor to re-unite, they are not converted into ſerum by their pretended diviſion, of which in fact (as we ſhall ſee hereafter) they have neither the characters nor the intimate nature.

6. The entire blood, which we ought to examine before its particular parts, when expoſed to a mild temperature and which does not exceed 100 degrees of the centigradel thermometer, diffuſes but very little vapour in the air, thickens and coagulates, aſſumes a brown colour much reſembling that of the liver of animals, and gradually dries if we agitate it, ſo as to be converted into an almoſt black powder, greaſy to the touch, and which keeps without alteration in well cloſed veſſels; in the air it becomes a little moiſt and covered with an efflореſcence of carbonate of ſoda. The coagulum of the blood dried in the air becomes ſenſibly attractable by the magnet; heated more violently in a crucible, it ſoftens, becomes as it were oily,

melts, ſwells, inflames and is reduced into coal, after having exhaled a very fetid ſmell. What is diſengaged during this ſtrong and decompoſing action of the open fire preſents a ſeries of products which I have carefully deſcribed; firſt, ammoniacal water; ſecondly, a white and very pungent vapour of carbonate of ammonia, and ſoon a yellowiſh thick ſmoke very fetid, which is manifeſtly oily and inflammable; afterwards Pruſſic acid recognizable by its ſmell of bitter almonds; then phoſphoric acid, announced by ſome flames emitted from the coally and red-hot matter; finally, carbonate of ſoda. There remains in the crucible a mixture of oxide of iron of a blackiſh or brown-black colour, granulated and cryſtallized; of carbon combined with a little iron, and almoſt in the ſtate of carburet of this metal; finally, of phoſphate of lime and muriate of ſoda. We ſee that in this operation the conſtituent principles of the blood are ſeparated almoſt all into binary compounds, if we except the oil and the Pruſſic acid. It is to be obſerved that when the blood is boiled in a baſin of copper, this liquid diſſolves enough of the metal to yield, on calcining it with alkali, cupreous Pruſſiate, even in abundance.

7. When inſtead of treating the blood by the fire in open veſſels, we diſtil it in cloſe apparatuſſes, with a mild heat, eſpecially with that of the water bath, it affords much water, which has a faint ſmell, and putrefies and becomes fetid when kept; the blood at the ſame time

is found coagulated into a brown ſubſtance and even dried. If we afterwards diſtil it in a retort, by a well managed fire till the bottom of the retort of porcelain, in which this diſtillation ought to be performed, is red-hot, we obtain fetid water charged with carbonate and zoonate of ammonia, beſides an ammoniacal ſoap which gives it a red-brown colour; an oil, at firſt red and light, afterwards brown, blackiſh, thick and almoſt concrete, very fetid, and which, before it condenſes, fills the receivers with a thick white vapour of cryſtallized carbonate of ammonia; and laſtly, carbonated and ſulphurated hidrogen gaſes. There remains in the retort a ſpongy coal, of a brilliant and as it were metallic appearance, adhering very ſtrongly to the veſſel, very difficult to be incinerated, in which are found by analyſis, beſides the carbon united with a little iron, phoſphate, muriate, and carbonate of ſoda, phoſphate of iron and phoſphate of lime. Though this diſtillation by a naked and violent fire, the only means of analyſing the blood that was formerly poſſeſſed, does not afford the real principles of the blood as was formerly believed, it correſponds with what has already been indicated in the hiſtory of the general characters of animal ſubſtances, and like the treatment by the open fire, it ſhows us what are in general the primitive principles of the blood.

8. Blood, expoſed to the air, after it has been drawn out of its veſſels, fixes or concretes

more or leſs ſpeedily; it forms, either an almoſt ſolid maſs, red without and black within, or a ſubſtance as it were gelatinous, tremulous, reſembling currant-jelly, according to the age and the ſtrength of the individuals from whom it is taken. It is this ſpontaneous coagulation which cauſed the ancients to adopt the notion of its plaſtic power, and to conſider the blood as a kind of liquid fleſh. Some hours after this ſpontaneous concretion into a ſingle homogeneous maſs, the blood ſhrinks, condenſes, and there ſeparates from it a liquid of a greeniſh white colour, which is called the ſerum of the blood. Though this double effect takes place in cloſe veſſels as well as in the air, the latter favours its production; its mere contact converts the black colour of the coagulum into a brilliant red; ſoon, and eſpecially when the atmoſphere exceeds twelve degrees or the temperate heat, the blood ſoftens, melts, diſſolves, exhales a ſmell, at firſt faint, afterwards fetid, and at laſt is completely decompoſed by putrefying. The moiſture of the atmoſphere accelerates this putrefaction, whereas great dryneſs combined with a high elevation of temperature in the air, dries this liquid and thickens it, inſtead of giving riſe to the ſeptic decompoſition like the preceding; the contact of oxigen gas renders the colour of the blood brilliant; azotic and hidrogen gas, on the contrary render it brown or violet; ſulphurated hidrogen gas blackens it.

9. The blood is entirely ſoluble in water when it is perfectly liquid; when it is coagulated the water diſſolves only its red part and leaves the fibrous, ſolid and white part of the coagulum inſulated: this is the means which is put in practice in order to ſeparate theſe two ſubſtances, and form the commencement of an analyſis of the blood both immediate and ſimple. If we throw blood into water heated above 45 degrees of the centigrade thermometer, this liquid preſents a number of floating pellicles or membranes; we ſee this effect in blood-letting at the foot. Above the temperature here indicated in the water into which it is thrown, the blood is entirely coagulated into brown flakes which condenſe and ſhrink together. Long continued maceration of the blood in water favours its putrid decompoſition, the colouring matter is precipitated and becomes darker, and the ſolid ſubſtance of the coagulum at laſt aſſumes the character of adipocerous fat. Sometimes two parts of water and one part of blood having been coagulated by fire, the liquor ſeparated from the coagulum, evaporated ſlowly, yields a bilious extract: it was in this manner that I demonſtrated the preſence of bile in the blood in 1790.

10. The acids when mixed with fluid blood coagulate and decompoſe it, rendering its colour darker, and more or leſs brown when they are concentrated. The concentrated ſulphuric acid renders it very brown and reduces it to coal. The nitric acid, whilſt it coagulates it, diſen-

gages from it much azotic gas, and converts its ſubſtance into carbonic acid, oxalic acid, and fat matter; the muriatic coagulates it without ſenſibly altering its colour; the oxigenated muriatic acid turns it black like ink. The vegetable acids only thicken it; the acetic acid is the only one of them which effects its coagulation. The cauſtic alkalis, on the contrary, liquefy and diſſolve the blood even when coagulated by the acids; if we mix them with blood recently drawn and which has not yet coagulated, they prevent its coagulation. It has already been ſeen how the alkalis, heated ſtrongly with this liquid, become in part ſaturated with Pruſſic acid.

11. Many ſalts have been mixed with the blood, and their effect has in general been found to correſpond by the antiſeptic property and the ſoftening or liquefaction which they effect, as well as by the obſtacle which they oppoſe to its coagulation. At one time this effect of the ſalts and of the ſaline ſolutions upon the blood was conſidered as an indication of their medicinal virtue; but this notion was ſoon diſcovered to be a real error, dangerous to the art of healing. The earthy ſalts in general are decompoſed by the blood by means of the ſoda which it contains.

The metallic oxides have no ſenſible action upon the blood, except thoſe which by eaſily yielding their oxigen coagulate it. Almoſt all the metallic ſolutions precipitate and coagulate the blood; they act eſpecially upon its albuminous part; it is almoſt ſuperfluous here to add that theſe two claſſes of bodies, the alkaline and the metallic ſalts, preſerve the blood and defend it againſt putrefaction.

12. Moſt of the immediate materials of vegetables, and even of the entire plants, produce this latter effect upon the blood and act upon it as antiputreſcent; it is eſpecially in ſugar, the volatile oils, camphor, the reſins and the balſams, that we find this property. The ſolutions of gum and of ſtarch coagulate it.

Tannin precipitates the blood abundantly; gallin and the pure gallic acid blacken it and form in it an atramentous depoſition, which without any other experiment is ſufficient to indicate the preſence of iron in it. We may obtain this precipitate by diluting the blood with much water. At the ſame time the aſtringent property of the gallic acid and of the extract which accompanies it in the gall-nut, thickens, condenſes and even hardens the ſolid matter of the blood; the ſame effect is obſerved in all the aſtringent vegetable ſubſtances, particularly in Peruvian bark, Simarouba, the peel of the pomgranate, ſumac, the outer ſhell of the wallnut, tea, &c.

Alcohol, poured upon the blood, alſo effects its coagulation, but it precipitates it only in ſmall flakes, which water ſeparates and dilutes ſo as almoſt to diſſolve them.

13. The blood, like all the other particular animal matters, has its mode and peculiar phenomena of putrefaction. Its colour grows darker and brown, it loſes its conſiſtence, its odour becomes inſufferably fetid; there are ſeparated from it a great number of membranous flakes, brown pellicles which gradually grow blacker; a conſiderable quantity of ammonia and carbonic acid gas is diſengaged from it. It requires a very long time before it entirely loſes its form, and characters of blood, before it becomes a ſolid, thick extractiform matter, and eſpecially before it is reduced to a ſpecies of mould. There are then found in it nearly the ſame materials as in the coal which remains after its diſtillation or combuſtion, except that this reſiduum retains a greaſy or unctuous feel, which announces in its alteration a well-marked production of fat matter.

SECTION III.

Of the Separation and Claſſification of the immediate Materials of the Blood.

14. THOUGH all the chemical characters of the entire blood are not without intereſt, they are however not ſo well marked or ſo important as thoſe which belong to its immediate elements, to the different materials which ſeparate ſponta-

neouſly from it. It is known that this liquid, when left to itſelf as it iſſues out of the veins or the arteries of the living animal, preſents, whilſt it is hot and fluid, an odorous exhalation which has been conſidered as one of its principles; that it ſoon coagulates or concretes into a tremulous gelatiniform maſs, which condenſes, ſhrinks, gradually approaches in its parts, and expreſſes from itſelf a liquid of a yellowiſh white colour and tranſparent; that it then reſembles a kind of curd, a floating red cake, which has been called *cruor*, *clot*, or *inſula rubra*, that this formation does not take place in the ſame manner when the blood has been violently agitated; that by this agitation, which is frequently practiſed in the ſhambles, there is ſeparated from the blood a remarkable quantity of fibrous matter, ſolid, whitiſh, and ropy, as it were, which attaches itſelf to the ſtick which is employed to ſtir it; that when the ſerum or the white part has been ſeparated from the coagulum, this, waſhed with water thrown in a ſtream upon its ſurface, is ſeparated into two matters, the one of a red-colour, diſſolved in the water with which it has been waſhed; this is the colouring matter of the blood; the other, ſolid, white, filamentous, which is called fibre, or fibrine. Thus there are five matters to be examined in particular; namely, the odorous exhalation, the ſerum, the coagulum, the colouring matter and the fibrous ſubſtance. I ſhall firſt remark that theſe immediate materials of the blood, when once ſeparated from each other, or even two of them, the coagulum and the ſerum, inſulated ſpontaneouſly, cannot again be united, or combined ſo as again to form blood, and that when once the connection is broken between them by their ſeparation from the living body and the ceſſation of the vital motion, their primitive compoſition can no more be made to re-appear.

SECTION IV.

Of the Odorous Exhalation of the Blood.

15. I DISTINGUISH amongſt the principles belonging to the blood the odorous exhalation; in order to conform to the opinion of the moſt celebrated phyſiologiſts who have conſidered it as one of the moſt important elements of this liquid, and who have attributed to it very powerful effects in the animal economy. Some modern philoſophers have thought that this principle was a particular gas, and it is according to this idea that Citizens Deyeux and Parmentier have made experiments upon this exhalation in their new analyſis of the blood. It reſults from their experiments that this principle cannot be obtained inſulated in the form of gas, that when it was condenſed in a bottle of which the blood, which had been put in quite hot, filled one part, and of which the portion

full of air received this odorous body: this air did not extinguiſh the tapers that were immerſed in it; that it did not precipitate lime water; that it was however ſufficiently ſtrongly impregnated with the ſmell of blood to communicate it to water by agitation, to diffuſe after ſome time a fetid ſmell, to extinguiſh theſe lighted tapers, without however containing ammonia; that it was then a little leſs pure by the teſt of the eudiometer; that the odorous water extracted from the blood by diſtillation on the water bath, and which yielded nothing to the re-agents, putrefied, depoſited flakes, and turned the ſyrup of violets green; that when it was heated in this ſtate it afforded a ſediment that burned upon the coals, with the ſmell of the retort. Blood, diſtilled with alcohol preſented to them, in its volatile product, the very diſtinguiſhable odour which it emits when it has been poured into water; yet this odorous alcohol ſhowed no effect upon the re-agents. The chemiſts whom I have quoted thought themſelves authorized to conclude from theſe experiments, that the aroma of the blood is the moſt alterable principle, and that which firſt changes the ſtate of this liquid by eſcaping in the volatile form. In the phenomena that have been indicated I can ſee only a ſmall portion of the entire matter of the blood raiſed in vapour with the water, and I find no relation between the experiments relative to this vapour and the uſes that have been attributed to it. It has been erroneouſly believed that the froth formed by the blood, ſpouting out and falling from an eminence, was a proof of this gas: it is only air confined by the viſcidity of this liquid.

16 Though I do not admit a particular principle of the odour of the blood; it is nevertheleſs of importance to know that this odour is one of the moſt marked characters, one of the moſt ſtriking differences which are found in this liquid, conſidered under different circumſtances. The odour of the blood is very feeble in infants and in females; it becomes very ſtrong at the age of puberty, as ſoon as the ſeminal fluid is formed in abundance and collected in its reſervoirs; it has then ſomething ſtrong, acrid and even fetid. The blood of eunuchs is deprived of it, as well as that of old men; accordingly ſome phyſiologiſts have believed that the ſmell of the blood and of the fleſh, to which it communicates itſelf, is owing to the ſpermatic fluid volatillized, diffuſed in the cellular texture of the body, and penetrating into all its regions. Bordeu has ingeniouſly treated this remarkable ſubject as one of the ſymptoms of the ſpermatic cachexy, in his medicinal analyſis of the blood.

SECTION V.

Of the Serum of the Blood.

17. THE name of ſerum, water of the blood, and the improper one of lymph, are given to the liquid which ſeparates from the coagulated blood when it has not been agitated; it is the thinneſt and the lighteſt liquid contained between the interſtices of the coagulum, and expreſſed out of its cavities by the approximation and attraction of the molecules of the cruor. The ſerum is of a greeniſh yellow colour, of a ſaline and inſipid taſte, of a conſiſtence ſufficiently viſcid to glue the ſkin ſlightly, when rubbed between the fingers. Its proportion is very variable and cannot be fixed; however, ſeveral phyſiologiſts have attempted to determine its quantity. Hamberger ſuppoſed it to conſtitute a third of the weight of the blood; Schwenke believed it to conſtitute two thirds; Drelincourt and Boyle admitted it to be one half; Queſnay three quarters; Vieuſſens gave for the red part 0,62, and for the ſerum 0,38; Homberg indicated five parts for the ſerum, and three for the red matter. According to Robinſon, it is much more abundant in young animals; the cruor or the red part augments with age, and a period arrives in which the

proportion

proportion of the ſerum deſcends to one third of the red ſubſtance. It is alſo ſaid that the blood contains more ſerum after meals, and that when the individual is faſting it has much more ſolid matter. Lower and Haller attributed this effect to the chyle poured in by digeſtion. Muſchenbroeck, Martyne, Schwenke, Jurin, indicate the ſpecific weight of the ſerum compared with that of water as 1027 to 1000.

18. The ſerum expoſed to the fire coagulates or hardens, and becomes opaque like white of egg. This property is one of the characters by which it is eminently diſtinguiſhed; it is attributed to a particular matter eaſily recognizable by that circumſtance, and which is called *albumen*, becauſe it is the ſame which exiſts in the white egg called *albumen*. When it is gently heated in this ſtate of coction or coagulation, the coagulated and ſolid ſubſtance becomes hard, brittle, and ſemi-tranſparent like horn. Heated by fire in the retort, it affords ammonia, carbonate of ammonia, fetid oil, ſulphurated hidrogen gas, and a coal in which are found muriate, phoſphate, and carbonate of ſoda. The ſerous liquor of the blood is alſo capable of turning the colour of violets green, which is likewiſe a property which it has in common with the freſheſt white of egg. According to theſe experiments, however ſimple they may be, the ſerum of the blood is conſidered as a combination of an albuminous matter with ſoda; a combination in which the

alkali united with the albumen, preſerves its properties as it does in ſoap.

19. The ſerum turns the ſyrup of violets green, and the tincture of curcuma brown; it conſtantly exhibits the alkaline properties; expoſed to the fire, it becomes concrete at the temperature of ſeventy-five degrees of the centigradel thermometer. This phenomenon, which was firſt obſerved by Harvey, the immortal author of the diſcovery of the circulation of the blood, is one of the moſt important which this animal ſubſtance preſents: every one knows it in the white of egg; but it differs ſenſibly in the ſerum, as this liquid, being not ſo thick as white of egg, neither acquires the ſame ſolidity, nor the ſame opaque whiteneſs in its concretion. Though it forms a maſs, it is always tremulous; it is found filled with bubbles, and manifeſtly formed of two different ſubſtances when it has cooled after its coagulation; its colour is a pearl-grey, it retains a ſemi-tranſparency; there is obſerved in it a ſofter portion, leſs opaque, frequently interpoſed between the particles and in the middle of the moſt opaque grey maſs, ſometimes collected at its ſurface, eſpecially when it has been coagulated ſlowly and by a well-managed fire. When this portion does not ſhow itſelf in this manner, which is the caſe when the ſerum is too liquid and too aqueous, the part which does not become fixed, when evaporated and left to cool, concretes into a

real jelly. The portion which, by the action of the fire, is congealed, and becomes opaque and inſoluble, is called albumen, from its analogy with the white of egg; the more tranſparent matter which becomes fixed eſpecially by cooling, and which is ſoluble in water, is termed gelatin. Chemiſts were unacquainted with its exiſtence in the ſerum of the blood, till I diſcovered it to be preſent in it, in 1790. We ſhall ſoon ſee from whence the coagulation of the ſerous albumen proceeds: it is neceſſary here to obſerve, that its concretion by heat always leaves it viſcid, gluey, tenacious, and not brittle, ſmooth and dry in its fracture, as we ſee in the white of egg hardened by the action of fire.

20. If we treat the ſerum of the blood by diſtillation on the water bath, it affords a very large quantity of water ſlightly odorous, in every reſpect ſimilar to that which is obtained from the blood, and like it putreſcible. The ſerum coagulated and dried in this operation is brittle, hard, almoſt tranſparent, and of a yellow, orange, or brown colour: when ſtrongly heated and diſtilled in a retort, it affords water and fetid oil, carbonate of ammonia, partly concrete, and partly diſſolved in water, a little Pruſſiate and zoonate of ammonia, carbonated and ſulphurated hidrogen gas, and carbonic acid gas. There remains a very voluminous light coal, difficult to be incinerated, which contains, with the carbon, muriates of ſoda and of potaſh,

aſh, phoſphate of lime, and carbonate of ſoda. No metallic oxides are found in it. When the coagulated ſerum is ſlowly heated in a retort, ſulphur is ſometimes ſeparated from it, which Citizen Deyeux has alſo obtained from white of egg. A plate of ſilver immerſed in it becomes black, whilſt it is made to coagulate by the action of fire.

21. When expoſed to the air, the ſerum of the blood abſorbs oxigen from it, and exhales carbon into it, whereby a part of the atmoſpheric oxigen gas is converted into carbonic acid gas; in proportion as this liquid abſorbs the atmoſpheric oxigen, it becomes more concreſcible, more capable of being rendered ſolid by the action of the fire; it frequently becomes turbid, and depoſits flakes already ſpontaneouſly concreted. It is for the ſame reaſon that white of egg which has been kept expoſed to the air boils quicker than that which is freſh, that the ſerum of the blood of animals which reſpire is more concreſcible than that of animals which reſpire little: I have thence concluded that the concreſcibility, the plaſtic nature of this humor, proceed from the fixation or the intimate combination of oxigen. Of this we ſhall ſoon ſee other proofs. To this property of abſorbing air, the ſerum owes that of frothing by agitation which it poſſeſſes. Long expoſure to the air favours the ſpontaneous decompoſition of this humor, and accelerates its putrefaction; it then exhales a very fetid ſmell, acquires a brown

a brown colour, becomes ammoniacal, and at laſt leaves a kind of dark-coloured reſidue, which remains for a long time fetid, preceded by a ſoft or entirely melted putrilage, which exhales a great ſtench. The ſepticity of this liquor proceeds ſo rapidly, that Bucquet could not determine whether it paſſed into the acid ſtate before it acquired the ammoniacal character. It is preſerved from putrefaction by all the means indicated in one of the preceding articles.

22. The ſerum of the blood unites with water eaſily, and in all proportions. The aërated water renders it ſlightly turbid, and a ſmall portion of it concrete. Boiled water does not produce the ſame effect, but remains tranſparent. When we diſſolve ſerum in ten or twelve parts of water, the liquor which reſults from it reſembles milk, according to the obſervation of Bucquet : it is white and opaque ; it becomes rarefied, and riſes over the fire like that liquid ; it yields by evaporation membraniform pellicles; it is coagulable by the acids, &c. &c. The conſiſtent and viſcous ſerum has the property of rendering two or three parts of water ſolid ; for notwithſtanding this addition, it is rendered concrete by heat, and the water does not ſeparate from it, on account of the adheſion which it contracts with it. When this humour is diluted with five or ſix parts of water, and heated to ebullition ſo as to render the whole of the albuminous part concrete, the liquid that

is ſeparated from it, when properly evaporated, affords afterwards by cooling, a jelly which becomes fixed. It was in this manner that I diſcovered the gelatin in the ſerum of the blood.

23. The metallic oxides do not unite with the ſerum in general; but thoſe which ſuffer their oxigen to be eaſily diſengaged from them, and which adhere but feebly with it, ſuch particularly as the red oxide of mercury triturated for ſome time with the ſerum, paſs again into the metallic ſtate, or approach to it more or leſs; at the ſame time the ſerous albumen becomes thick, opaque, and more or leſs coagulated. This experiment, which I deſcribed in 1790, proves that oxigen favours the concretion of the albumen, and that, as I have already announced, No. 18, the plaſtic property proceeds from the fixation of this principle; ſo that the concreted albumen is a real oxide. When the metallic oxides are highly oxigenated, and adhere very little with the oxigen, their action goes ſo far as to burn and reduce the ſerum to coal. By this circumſtance is explained the catheretic or even cauſtic effect of the metallic poiſons. It is however to be remarked, that this effect of the oxides of mercury, of their diſoxidation by the ſerous albumen, has a boundary, that it extends only ſo far as to cauſe them to paſs into the ſtate of black oxide, and that in this manner we may conceive why running mercury triturated with ſerum is extinguiſhed or reduced to the ſtate of

black oxide. In theſe two experiments compared with each other, we ſee a new proof of the different attraction of different portions of oxigen for the ſame metal. The firſt portion is taken by the mercury from the albumen, and the ſecond by the albumen from the oxide of mercury.

24. All the acids coagulate the ſerum, ſeparate from it the albumen in flakes more or leſs denſe, and of a greyiſh-white colour, the more ſolid in proportion as the acids are more concentrated. All of them, after having produced this coagulation, remain in the ſuper-natant liquor, in part ſaturated with ſoda, which they have taken from the ſerum: ſome chemiſts have believed, on account of this effect, that the ſoda was combined with the albumen as it were in a kind of ſoap, and that it was this that rendered it ſoluble in water. Rouelle the younger conſidered it, however, as being almoſt entirely inſulated. Bucquet, on the contrary, maintained that it was intimately combined with it, and that even the acids took away only a part of the ſoda of the ſerum; in proof of which he adduced that the coagulum formed in this liquor by acid in great exceſs, contained ſtill carbonate of ſoda after its combuſtion and incineration: this fact however requires to be confirmed. The coagulation of the ſerum by the acids is prevented by mixing with it, before it is added to the latter, a certain quantity of the ſolution of an alkaline carbonate; the

effervefcence which the acid that has been added produces carrying off the caloric in order to reduce the carbonic acid to the ſtate of gas, no longer permits the mixture to become heated, and conſequently guards the albumen againſt the coagulation which it experiences without this addition.

25. Beſides this general effect of the acids upon the ſerum, each of them has ſome peculiar to itſelf. The concentrated ſulphuric acid turns it brown, and reduces it to coal; that which is diluted with water only coagulates and preſerves it. The nitric diſengages from this humour coagulated by fire, azotic gas, carbonic acid gas, Pruſſic acid gas, and converts the reſt into oxalic acid and fat. The fuming muriatic acid communicates a violet colour to the ſerum, or coagulates it; by a long contact it becomes ſaturated with ammonia by decompoſing this ſubſtance. All the other acids precipitate, coagulate, and preſerve the ſerum; ammonia eaſily diſſolves the albuminous coagulum formed in the ſerum by their action.

26. All the earthy and alkaline baſes have actions more or leſs marked upon the ſerum of the blood. The ſolutions of barites, of ſtrontian, and of lime, precipitate this liquor; the precipitate is a real inſoluble phoſphate. The leys of fixed alkalis render the ſerum more liquid; with the aid of heat they diſſolve its coagulated albumen. The cauſtic and dry pot-aſh or ſoda, triturated with this liquor when

thick or boiled, ſuddenly diſengage ammonia from it, and diſſolve a part of the remainder. When theſe alkalis are heated and calcined with coagulated ſerum, the ley which is made of the reſidue of this coagulation, is found to contain Pruſſic acid, and precipitates iron in the blue ſtate. When the ſerum is boiled with an alkaline ley much diluted, and when this liquor is filtrated, the weak acids poured into it diſengage from it a very perceptible ſmell of ſulphurated hidrogen gas: this is one of the proofs which Citizen Deyeux has adduced to prove the preſence of ſulphur in the ſerum of blood, which is beſides manifeſted by other experiments that have already been indicated.

27. Serum combines with moſt of the ſaline ſolutions, without experiencing any alteration from them, except being preſerved and defended againſt putrefaction. It however decompoſes the calcareous ſalts by virtue of the ſoda and phoſphate of ſoda which it contains; the precipitate which it forms in it is a compound of lime and phoſphate of lime. The ſoluble baritic ſalts produce no effect upon it. Thoſe of ſtrontian are decompoſed, and their baſe is precipitated by ſoda. The ſame is the caſe with the ſalts of alumine, of zircon, and of glucine. The ſoda of this liquor ſeparates alſo the ammonia from the ammoniacal ſalts, and this volatile alkali ſeizes the albumen of the ſerum, which it diſſolves, or at leaſt renders more fluid.

28. I have already ſaid, that the metallic oxides thicken and coagulate the albumen; and it is evident that, combined with the acids, they muſt produce this effect in a ſtill more powerful manner, as they are aided by the latter, which themſelves alſo produce it in a very marked manner. When we pour a metallic ſolution into the ſerum of the blood, there is ſuddenly produced in it a thick and coagulated precipitate, formed by the metallic oxide and albumen. But beſides this, the muriates, the phoſphates, and the ſoda which it contains, occaſion another kind of decompoſition in the metallic ſalts: ſo that the precipitate which they form in them is generally compoſed of four ſubſtances, the oxide ſeparated by the ſoda, the oxide united with the albumen, a muriate and a phoſphate of the ſame oxide. Such eſpecially is the effect of the nitric ſolutions of the white metals, of mercury, of lead, and of ſilver; the latter alſo ſhows the ſulphur in it by the black ſtreaks which it forms in it. Theſe precipitates, eſpecially that of mercury aſſume a roſe or fleſh-coloured tinge. The ſerum treated in this manner has become unalterable and imputreſcible. There are ſome metallic ſalts which are capable of uniting with the ſerum without decompoſition: ſuch eſpecially is the phoſphate of iron with exceſs of oxide, which colours it red.

29. Some vegetable matters act in a particular manner upon the ſerum. Alcohol coagulates

it and precipitates it in ſmall whitiſh flakes, which eaſily divide in water and remain ſo well ſuſpended in it that we might conſider it as diſſolved. Bucquet had even announced that the coagulum formed by alcohol was entirely ſoluble in water, and diſappeared when a ſufficient quantity of this liquid was added. The fixed oils are rendered miſcible with water by the ſerum of blood. The volatile oils, camphor, the reſins, the balſams, and the gum-reſins, preſerve this liquid, and prevent its putrid decompoſition. Tannin is of all the immediate materials of vegetables that which has the moſt remarkable action upon the ſerum of the blood: it precipitates itſelf abundantly into a yellow, gold-coloured, ropy, and pitchy ſubſtance, inſoluble in water, which dries and becomes brittle in the air, which has no longer any kind of alterability, and which reſembles leather too much tanned and become dry, hard and brittle, by exceſſive tanning. The gelatin and the albumen are equally precipitable by tannin, but the firſt is more eaſily dried than the ſecond; and though the diſtinctive characters of theſe two tanned ſubſtances have not yet been determined, it is no leſs certain that they preſent reciprocal differences which may hereafter ſerve to diſtinguiſh the one from the other, perhaps even to ſeparate them, and eſtimate their proportion.

30. All the facts relative to the properties of the ſerum of the blood prove, that this liquid is a kind

a kind of animal mucilage, compoſed of albumen and gelatin in different proportions, diſſolved in a variable quantity of water, conſtantly combined with pure ſoda, which is united with the albumen almoſt in a ſaponaceous combination: we alſo find in it muriate of ſoda, phoſphate of ſoda, ammoniacal phoſphate, and phoſphate of lime. The latter appear to be not eſſential to its combination: not only their proportion varies; but they may exiſt or not exiſt, be in the number indicated, admit of the abſence of ſome of them, or the ſimultaneous preſence of a greater number. For example, we may find in it muriate of pot-aſh, phoſphate of magneſia, or ammoniaco-magneſian phoſphate, &c. without the albuminous alkaline and gelatinous matter of the ſerum of the blood changing or preſenting properties foreign to thoſe which characterize it.

SECTION V.

Of the Coagulum or Cruor.

31. WHEN the blood, after ſeveral hours coagulation, has afforded all the ſerum that can run, and be expreſſed from it, the coagulated, half ſolid, and contracted ſubſtance which ſwims in the middle, is known by the name

of *coagulatum, placenta, inſula.* This maſs has been called *cruor* before the means of ſeparating it into the two different matters which conſtitute it, had been diſcovered.

It appears that the differences of proportion between the ſerum and the cruor, that have been admitted by the different authors, are owing to its variable quantity, Wieuſſens eſtimated it at 0,62, and gave only 0,38 to the ſerum; Homberg gave five parts to the latter and three to the cruor; Schwenk reckoned the ſerum at two-thirds, and the cruor at one-third; Queſnay the ſerum at three-fourths, and the cruor at one-fourth; Senac the ſerum at four-fifths, thee cruor at one-fifth; Schwenk admitted it to be only one-eighth. Boerhaave adopted the latter proportion. In general phyſiologiſts, according to Haller, think that the cruor increaſes as the individual advances in years; that the ſerum predominates in young animals; that thoſe which are vigorous afford more cruor, and that when they are debilitated or badly fed, this matter diminiſhes in them. Nevertheleſs it reſults from this compariſon of opinions and facts, that the cruor or the ſubſtance of the coagulum is in general leſs abundant than that of the ſerum. It is alſo to be obſerved that the proportion of this ſolid or cruoric part of the blood diminiſhes more the longer we leave the ſerum to ſeparate, and that it always tends, by ſhrinking together, to preſs out a larger portion of the gelatino-albuminous liquid.

The blood coagulates, or aſſumes the concreteſtate in cloſe veſſels as well in open ones, in the heat as well as in the cold; it is therefore, neither the air nor refrigeration which coagulate the blood, but the privation of the vital motion.

This coagulum is formed ſooner or later; its conſiſtence varies from the tremulous ſoftneſs of currant-jelly to the ſolidity of a kind of leather. In youth and in females it is ſofter; in old age its tenacity is very great. When the blood becomes covered with a buffy coat in ſome particular diſpoſitions of the ſubject, or in inflammatory affections, it is obſerved that the coagulated and red part which it covers is leſs ſolid and leſs abundant; which proves that the ſubſtance of this coat, is formed at the expenſe of that which forms the ſolid part of the coagulum. Blood received, as it iſſues out of the vein, into a ſolution of ſalts, nitrate of pot-aſh, or ſulphate of ſoda, does not coagulate.

Its ſurface which is in contact with the air is of a brilliant purple-red, its interior is dark coloured and almoſt black; but this interior part, when expoſed and opened in the air, aſſumes the clear and brilliant tinge of the ſurface. Incloſed in a veſſel full of atmoſpheric air, the coagulum quickly alters it, whilſt it becomes red, and converts the oxigen into carbonic acid. Hidrogen gas and carbonic acid gas give it a violet colour; the firſt of theſe gaſes becomes carbonated.

The coagulum corrupts rapidly and becomes inſupportably fetid. In a hot place, as a ſtove or an oven, it dries without putrefying, and becomes converted into a kind of powder. Thrown into boiling water it acquires more conſiſtence than it naturally has; its colour paſſes into an homogeneous brown; the water becomes turbid, and preſents at its ſurface an abundant ſcum; the acids thicken and harden it, at the ſame time rendering it brown. Alcohol heated upon the coagulum aſſumes a lemon colour and condenſes its texture. The alkalis on the contrary ſoften and diſſolve it; they change its colour leſs than the acids.

32. The coagulum being tied in a bag of linen, and waſhed under a ſtream of water till this ceaſes to be coloured by it, when the linen is ſlightly compreſſed between the fingers, ſeparates into two diſtinct ſubſtances, preciſely in the ſame manner as we have ſeen the paſte of the flour of wheat ſeparated into two ſubſtances by the ſame operation. We may alſo effect this ſeparation in the hand by uſing only a very ſmall ſtream of water, or upon a very cloſe hair ſeive always with the ſame precaution of employing but very little water, and receiving it gently upon the ſurface of the coagulum. Theſe two matters are, 1. the red colouring part which diſſolves in the water and runs off

in the waſhing; 2. a white ſolid ſubſtance, filamentous and flaky, which remains in the bag, in the hand or upon the ſieve, and which is much leſs voluminous, and at the ſame time much more denſe than the coagulum. There is this very perceptible difference between the product of this operation and that of the waſhing of the paſte of flour, that the wheat yields ſtarch in powder; which renders the water turbid and milky; whereas the coagulum does not render water opaque nor leave any fecula precipitated, but permits the red colour to diſſolve in the liquid, which paſſes off tranſparent. By purſuing this compariſon, we ſee alſo that the white concrete ſubſtance obtained as reſiduum of this waſhing correſponds with the glutinous part of wheat, and that the coloured liquor of the cruor that has been waſhed repreſents at the ſame time the amilaceous fecula and the mucoſo-ſaccharine matter of the flour.

SECTION. VI.

Of the Colouring Part.

33. THE water which is employed for waſhing the coagulum of the blood, takes from it the whole of its colour and acquires a more or leſs brilliant-purple tinge. This is what is termed the colouring part of the blood. It appears to

be nothing more than a dilute ſolution of albumen and gelatin, with which a ſmall quantity of iron, in the porportion of a few thouſandths is mixed. It is thus that Bucquet has deſcribed it, comparing it with the ſerum, from which it appears to differ only by the metal thus indicated. This difinition could not enable us to underſtand the adheſion of this ferrugineous ſerum with the coagulum, and the ſeparation of the white ſerum which is effected, except as a ſimple expreſſion of the thinneſt and moſt fluid part of the liquid, and as the more intimate attraction of the portion condenſed by the oxide of iron for the concrete and fibrous part of the coagulum. But ſuch a general or ſuperficial notion is not ſufficient; we muſt ſtudy with greater attention the properties of the ſanguine colouring liquor, and inveſtigate thoſe which particularly characterize it.

34. The aqueous ley of the coagulum, which is tranſparent at the moment when it has juſt been obtained, becomes turbid and depoſits membranous flakes at the end of ſome time; it turns the ſyrup of violets green. Even when heated on the water-bath, it forms a brown coagulum, which ſwims in a turbid water. This coagulum ſeparated from the liquid portion by filtration, preſſed and dried, becomes brittle, pulverulent, inſipid and inodorous. We ſee it in what is called the *ſcum of the pot*, when the entire fleſh is boiled in water. Alcohol takes

from it but very little, and aſſumes a red colour. The acids blacken and alter it, they alſo form it and ſeparate it from the water by coagulating it. The pure alkalis diſſolve it, and it is precipitated from them by the acids. The coloured coagulum affords in diſtillation the ſame product as that of the white ſerum, and it preſents ſo many analogous properties that it is impoſſible not to confound it with the albumen of the former liquor. One difference however preſents itſelf when we compare their coat, ſince that of the red ſerum contains iron, as ſhall be ſhown.

35. When we ſeparate, by the action of fire, the ferrugineous albumen from the large quantity of water in which it is diſſolved, whatever temperature may be employed, and whatever time we may beſtow upon this ſeparation, we can never obtain it entire; becauſe the part which is coagulated fixes about a fifth of water in which it was diſſolved; the ſupernatant liquor alſo retains a portion of albumen, and there is eſtabliſhed an equilibrium of combination, a mutual partition between theſe two bodies. Alſo by evaporating the liquor that is not thickened, after having ſeparated it by filtration from the ſolid and coagulated matter which it contained, it preſents at its ſurface towards the end of the evaporation, a brown pellicle, which breaks and is precipitated into coloured flakes. When it is denſe and clear, alcohol heated upon it diſſolves a part of it, aſſuming a deep brown

colour, and leaves by evaporation a reſiduum of animal matter, ſoluble in water, frothing by agitation, like a ſolution of ſoap, ſtrongly turning the colour of violets green, and precipitated by the acids. Theſe laſt properties indicate that the albumen combined with ſoda actually reſembles a ſaponaceous combination.

36. When Menghini diſcovered the preſence of iron in the blood; when Rouelle confirmed it by new experiments; neither of theſe chemiſts determined in what ſtate this metal was contained in it. Citizens Deyeux and Parmentier believed it to be combined with ſoda, and in a ſtate nearly reſembling that of the ferruginous alkaline tincture. The following is the manner in which Citizen Vauquelin and myſelf found that the iron was united in it with phoſphoric acid, as Citizen Sage had announced a long time before, but without proving it, and as Mr. Grew, Profeſſor at Halle, had aſſerted more poſitively, though he did not indicate by what means we might be convinced of it. When the red part of the water in which the coagulated blood has been waſhed is burned in a crucible, we obtain a reſiduum of a dark red colour, forms 0,0045 of the blood that has been employed, but which, when diſſolved in the muriatic acid, amounts only to between 0,0017 and 0,0006 when ſeparated from what is foreign to it, or thoſe ſaline matters which do not contain iron, by the following proceſſes. It is digeſted in very weak nitric acid, which

diſſolves a part of it, and leaves another more red than before. Ammonia poured into this ſolution affords a white precipitate, which when treated whilſt ſtill wet by cauſtic pot-aſh, loſes part of its weight, and aſſumes a very dark-red colour. Lime water, poured into this ley of pot-aſh, forms a white precipitate of phoſphate of lime. We may employ muriatic acid for diſſolving the phoſphate of lime, which remains after the combuſtion of the coagulated red ſerum.

37. In order that we may be the better able to conceive the nature and the ſtate of this phoſphate of iron, and underſtand how it can be diſſolved in the blood along with ſoda, it muſt be obſerved, that there are two phoſphates of this metal, the one white-grey, frequently of a pearly brilliancy, inſoluble in water, ſoluble in the acids, and the other red, more or leſs brown, and leſs ſoluble in the acids; this is phoſphate with exceſs of oxide of iron, and the other is ſaturated with its acid. The white phoſphate of iron is decompoſed only in a partial manner by the cauſtic alkalis, which take from it only a part of its acid, and leave the ſalt with an exceſs of this baſe. It is in this ſtate of phoſphate ſuperſaturated with iron, a ſtate maintained by the preſence of the ſoda, that this metal is diſſolved in the blood, and in particular in its ſerum. The blood of all animals, when it is red, is coloured by the phoſphate of iron.

38. We have found in our experiments relative to the colouration of the blood, that the ſuper-oxigenated phoſphate of iron has an exceſs of its baſe, that this phoſphate diſſolves very well, and by the ſlighteſt agitation or trituration, in raw white of egg, and in the ſerum of the blood: it is not even neceſſary to employ the aid of heat in order to effect this ſolution, ſince it takes place in the cold by mere motion, preſenting immediately a very ſtrong red colour, which reſembles that of the blood. A little pure fixed alkali accelerates this ſolution, and renders its colour more perfect and lively. Thus the phoſphate of iron, the quantity of which, though very ſmall, is ſufficient to colour the blood, exiſts in it in the ſtate of ſuper-oxidation, and of exceſs of metal; it is diſſolved in its albumen, and brightened by the ſoda contained in it. Perhaps the phoſphate of ſoda exiſting in the ſerum has no other origin than the partial decompoſition of the phoſphate of iron by the ſoda.

39. Amongſt the properties which diſtinguiſh the red ſerum, or the colouring part of the blood, we muſt particularly mention its change of colour by the contact of the air; the luſtre imparted to it by the oxigen gas, or the aërated water employed for waſhing the coagulum; the violet brown, which it contracts from carbonic acid gas, and eſpecially from carbonated hidrogen gas; the influence which it has upon the alteration of the air, the formation of carbonic acid which it excites, and the abſorption of oxigen which it produces. If theſe phenomena

are more energetic and more prompt in the red ſerum than in the white, and if the difference which exiſts between theſe two ſpecies of ſerum entirely depends upon the preſence of the ſuper-oxigenated phoſphate of iron which the firſt contains, it is evident that this metallic ſalt is the cauſe of the colouration of the blood, and of the luſtre which this colour acquires by the contact of the atmoſphere, as alſo of the changes which this red ſerum, at the ſame time, occaſions in the air in which it is immerſed.

40. Citizen Deyeux believes, that the colouring matter of the blood, beſides albumen, gelatin, the phoſphate of iron, and the ſalts, which analyſis has diſcovered in it, contains a particular ſubſtance, to which he attributes ſeveral of its characters, and eſpecially the homogeneous concretion of the entire blood in the preparation of puddings; on which account he calls this ſubſtance *matière tomelleuſe*. It is ſince his inveſtigations concerning the blood that he appears to have directed his attention to this matter, as he had ſaid nothing at all of it in the Journal de Phyſique, in which his firſt analyſis is inſerted. He has diſtinguiſhed the tomelline; for it is uſeful to give to his name a termination ſimilar to that of ſeveral other animal ſubſtances, with which it appears to have much analogy in its form, its conſiſtence, as well as in ſeveral properties which have appeared to him to be different from thoſe which are known in the albumen, the gelatin, and the fibrine.

But he has himſelf given the firſt notions relative to this particular matter, only as mere ideas, which deſerve to be verified and purſued, in order to receive from experience, that confirmation which alone can prove the exiſtence of this new body.

41. I muſt not omit, amongſt the properties of the colouring matter, or of the red ſerum of the blood, that of diſſolving copper, which preſented itſelf to Citizen Vauquelin with ſo remarkable an energy as to induce him at firſt to believe that the blood contained this poiſonous metal amongſt its principles. The following is the manner in which this diſcovery preſented itſelf to him. Having boiled the water in which the blood had been waſhed in a very clean copper kettle, in order to coagulate the albumen, and having filtrated the liquor in order to collect ſeparately the coagulated matter, with the intention of carefully examining its colouring part, he burned this concrete ſubſtance in an earthen crucible, and diſſolved its ferrugineous reſiduum in the muriatic acid. When he attempted to precipitate the ſolution by ammonia, he was much ſurprized to ſee the liquor, which contained an exceſs of this alkali, aſſume a beautiful blue colour. The liquor was ſaturated and diſcoloured by the muriatic acid, and a plate of iron that was immerſed in it became covered with a brilliant ſtratum of copper, the quantity of which was ſufficiently conſiderable after two days to be able to be ſeparated and

detached from the iron. The water from which the coloured albumen had been ſeparated by coagulation, contained no copper; whence Citizen Vauquelin concluded that the ſolution of the copper was owing to the albumen; that it was effected at the moment of the ſeparation of the albumen by the heat; that the copper combined and precipitated itſelf with the concrete albuminous matter. In fact, this more oxigenated part of the blood exerts a very marked attraction upon the metallic oxides, combines with them with conſiderable force, and ſeparates them, as we have ſeen, from the acids. According to this fact, it is an important caution, that blood prepared for food ſhould not be boiled in copper veſſels. It is alſo to be obſerved, that in precipitating an alkaline ley of blood by the acids, we obtain more Pruſſiate of copper than even Pruſſiate of iron. The firſt is recognized by its purple-red colour when it is moiſt, and its dark-red colour when dry.

42. The red ſerum of the blood, or the colouring part of this liquid, obtained by waſhing the coagulum, after the ſeparation of the ſerum, or of the white ſerous part, is therefore compoſed of a large quantity of water, of albuminous and gelatinous matter, of ſuper-oxided phoſphate of iron, of ſoda, and of ſome ſaline ſubſtances. The latter, and particularly the phoſphates and muriates, are much leſs abundant in it in their proportion with the albumen than

in the ſerum properly ſo called, ſince this, which has flowed ſpontaneouſly out of the coagulum, and which was its moſt fluid part, muſt have carried off with it all the more ſoluble parts that were contained in it, and the ſalts hold the firſt rank in this order. It is very evident that we do not ſpeak here of the proportion of the materials of the red ſerum to the water which diſſolves them, as we may conſider it in the white ſerum, becauſe the quantity of the water added, depends entirely upon the will of the perſon who operates, and the proceſs which he employs. The ſuper-oxigenated phoſphate of iron, or the red phoſphate of iron, which colours this ſerum, ſeparated from the coagulum, is diſſolved in it by the albumen, and is precipitated with it when the fire coagulates and ſeparates it from the water; this albumen retains even a part of its diſſolvent activity, ſince beſides the ferrugineous ſalt which it naturally contains, it re-acts ſo quickly and ſo powerfully upon the copper, and undoubtedly upon other metals. We may underſtand the ſimultaneous preſence of phoſphate of iron, and of ſoda in the blood, when we know the fixed alkali decompoſes this metallic ſalt only in part, and reduces it, like the Pruſſiate of iron, only to the ſtate of phoſphate with exceſs of iron, or red phoſphate, and that it is in this ſtate in the blood; we comprehend it ſtill better when we recollect that iron, which is oxided in a ſolution of phoſphate of ſoda, decompoſes a part of this ſalt, and paſſes into the ſtate of ſuper-oxigenated phoſphate of iron. Perhaps, it is alſo in this manner, that this ferrugineous ſalt is formed in the blood, and that the ſeparation of the ſoda is effected.

SECTION VII.

Of the fibrous Part of the Blood, or of the Fibrine.

43. WHEN the coagulum, tied in the linen bag, has been well waſhed, there remains a white matter in hard filaments, interlaced with one another in a texture reſembling felt, which has been called *fibrous matter*, and which is denominated *fibrine* in the methodical nomenclature. This ſubſtance ſeparates itſelf from the blood when it is agitated in the ſhambles, and attaches itſelf to the ſticks with which it is ſtirred, in the form of ſmall ſolid faſciæ, twiſted together like intermingled threads, of a roſe-colour, which become white by waſhing. We conſtantly find it ſtill floating in ſmall flakes, or in whiteiſh fibres, in the water into which the blood is received in blood-letting at the foot; ſometimes ſimilar filaments come away with the blood in veneſection at the arm, and it cannot be doubted, that to theſe filaments are to be attributed the pretended worms which have

been ſaid to have ſeen iſſuing out of opened veins.

44. The fibrine when well prepared, drained upon paper without ſize, and dried in a ſtove, thereby loſes two-fifths, or between 0,39 and 0,40 of its weight. The medium quantity of this matter, taken from the blood of ſix different perſons, amounted in our experiments to 0,0028; in the blood of a greater number of perſons compared, the *minimum* of its proportion was 0,0015, and the *maximum* 0,0043. The fibrine is void of taſte, and of ſuch conſiſtence and tenacity in its texture, that animals cannot maſticate it without much difficulty. When it is expoſed ſuddenly to a violent fire, it ſhrinks and moves like parchment. When diſtilled by naked fire, and in a retort, it affords water charged with carbonate of ammonia, a thick, heavy, and very fetid oil, and much concrete ammoniacal carbonate. There is alſo diſengaged from it carbonated hidrogen gas, and carbonic acid gas: it is one of the animal ſubſtances which furniſh the moſt oil and ammonia; accordingly, I have indicated it as a ſubſtance particularly azoted. The coal which it leaves after its diſtillation is compact, heavy, and rather difficult to be incinerated. We find only phoſphate of lime in its aſhes; we extract it and aſcertain it by diſſolving it in the nitric acid, and precipitating it by ammonia. It contains neither ſoluble phoſphate nor iron.

45. The fibrine putrifies quickly and violently in water; it exhales a fetid ſmell, and is converted into an adipocirous fat ſubſtance; there is alſo diſengaged from it much carbonate of ammonia during its putreſcence. It is not ſoluble in water, and when left for a long time in this liquid in the boiling ſtate, it becomes hard like horn, aſſuming a grey colour. The alkalis, diluted with water, have very little action upon it; it is equally inſoluble in ammonia. The leys of cauſtic fixed alkalis, barites, pot-aſh, ſoda, and ſtrontian, highly concentrated, attack it, however, with the aid of heat; they give it a brown-red colour, diſengage ammonia from it, ſoften it, and at laſt entirely melt it. The reſult is a kind of bitter fluid and viſcous ſoap, which the acids and the metallic ſalts decompoſe.

46. The acids have a much more ſenſible action upon the fibrine. Even the weakeſt diſſolve it. Weak nitric acid diſengages from it in the cold much azotic gas, afterwards with the aid of heat Pruſſic acid gas, and carbonic acid gas, mixed with nitrous gas; there are then formed yellowiſh fatty flakes, and the liquor holds oxalic acid in ſolution. The concentrated ſulphuric acid reduces it to coal, converting it in part into water and acid. The muriatic diſſolves it, and gives it the form of a green jelly. The acetous acid alſo diſſolves it, like the citric, tartarous, and oxalic acids, with

the aid of a gentle heat. All theſe acid ſolutions aſſume, when they are concentrated by evaporation, or otherwiſe well ſaturated, and by cooling, the gelatinous form: they then reſemble a real jelly. The alkalis precipitate the fibrine from theſe acid ſolutions in flakes, altered indeed, and which have become ſoluble in hot water; it would then ſeem that it has aſſumed the character of gelatinous texture, and that it has experienced a kind of retrogradation in its compoſition.

47. We muſt add to theſe properties, which are already very capable of characterizing the fibrine, and diſtinguiſhing it from the other animal ſubſtances, that it affords, amongſt the products of its diſtillation, a remarkable quantity of the zoonic acid, diſcovered by Citizen Berthollet, and that it thus exhibits, in the experiments to which it is ſubjected, a very animalized matter, very much azoted, eſpecially which repreſents almoſt the laſt term of animalization, or of the animal compoſition. It is, perhaps, to an alteration of this ſubſtance, analogous to what takes place with it in its converſion into zoonic acid, that we have to attribute the acidification obſerved by Citizen Chauſſier, who aſſerts, that he has extracted a particular acid from the coagulum treated by alcohol.

48. Notwithſtanding the ſmall quantity of fibrine contained in the blood, we ſhall ſee hereafter, that it acts a very important part in the animal organization, and in the life of animals,

ſince it depoſits itſelf in their muſcles, the particular texture of which it conſtitutes, and ſince it becomes the ſeat of one of the moſt important and moſt incomprehenſible vital functions, that of irritability, and conſequently the principle of the motion which preſides over all the other functions, from that of the heart, in which the ſupport of life reſides, to that of the ſmalleſt muſcular fibre.

SECTION VIII.

Of the principal Differences of the Blood.

49. IT is not ſufficient to have examined the entire blood, and its different elements, or immediate materials in the moſt general circumſtances, or to have determined its properties, that are in ſome ſort mediate or common. Chemiſtry can proceed ſtill much farther; it ought to embrace a ſtill much greater whole, and apply itſelf to much more extenſive details. It is its buſineſs to appreciate the differences which this vital liquid preſents, according to the places which it occupies in the body, according to the ages and the ſex which modify it, according to the different orders of animals to which it belongs. Though the analytical labours which theſe data require, in order to be obtained, are yet but ſmall

advances, chemical knowledge has, nevertheleſs, already thrown ſome light upon theſe conſiderations, and it is important to collect thoſe lights, as it were, into a focus, in order at leaſt to illuminate the entrance of an immenſe courſe, which medicine expects in this reſpect from Natural Philoſophy, which muſt preceed her in his route hitherto ſo little frequented.

50. The ancients had ſome notions concerning the difference of the blood contained in the two orders of arterial and venous veſſels: by admitting in the firſt, a ſpirit, or an elaſtic air, they ſeemed to have conſidered the blood which circulates through them, as rarefied, aërated, and frothy. It is no longer doubted, ſince Harvey, that the blood of the arteries is more red, more hot, more rare, and more irritating than that of the veins, and pneumatic chemiſtry has ſhown, that in fact the arterial liquid owes theſe properties to the oxigen gas which it abſorbs in the lungs, and to the loſs which it has there ſuffered of a portion of its hidrogen, and of its carbon. In proportion as it circulates, it loſes both its heat, and its oxigen, and its proportions; ſo that having become of a brown-red colour, leſs hot, leſs concreſcible, more hidrogenated, and more carbonated in the veins, it is diſpoſed to become oxigenated, heated, diſ-hidrogenated, and decarbonated in the pulmonary veſicles; and we ſhall ſee that reſpiration has theſe ſimultaneous effects, as its object and its function.

51. To this difference of the blood in the ſyſtem of the arteries, and in that of the veins, we muſt add that which it acquires in the different regions through which it circulates. It has been believed to be more light, more aërial, more ſpirituous in the veſſels of the head, and diſpoſed thereby to form the nervous fluid or the vital ſpirit, which as yet is indeed only an hypotheſis. It is known, that it is fat and oily, or at leaſt very much diſpoſed to become ſo in the abdomen, and eſpecially in the ſyſtem of the vena porta; that it alſo undergoes a change that has not yet been appreciated in the ſpleen; that it is very much attenuated, and replete with life and activity in the ſpermatic ſyſtem. There is alſo no doubt, that it has a very particular character in the vicinity of the kidneys, and eſpecially where it iſſues out of this urinary organ, and in the emulgent veins, though it is not known in what this character conſiſts. It is no leſs evident, that near to the heart, and before it enters it in order to be ſent into the aëriferous apparatus of the lungs, the chyle which it receives, modifies and renovates it by furniſhing to it a pure ſource of continual reparation. We cannot miſtake the particular diſpoſition which it has to become ſolid and converted into fibrous texture, which it affects by being retarded in thoſe arteries, almoſt always retrograde, which carry it into the muſcular fleſh.

52. Mere inſpection is ſufficient to ſhow, that the blood varies according to the age and ſex of the individuals. That of the fœtus differs eſſentially from that of the infant after reſpiration has commenced, becauſe the air has not yet touched or impregnated it. Already the firſt experiments which I have been able to make upon this ſubject, have ſhown me that the blood of the human fœtus which has not yet reſpired, contains inſtead of the fibrous matter, only a ſoftiſh texture, without conſiſtence, and as it were gelatinous; that it is not ſuſceptible of being reddened by the contact of the air, like that of the adult, and that it preſents no phoſphoric ſalts.

Sometime after birth the blood aſſumes a bright colour, a more conſiderable concreſcibility, and it becomes enriched with phoſphates, eſpecially with that of lime, which being furniſhed in conſiderable abundance by the milk of the mother, quickly carries the ſolid matter to its bones.

At the age of puberty the blood is more hot, more highly coloured, more irritating, more odorous, and vivified by the ſpermatic emanation which prevails; moved with force in its ſtrainers, it tends to eſcape from them: and this is the epocha of turgeſcence and of hæmorrhages.

The blood of the ſubject that has become adult, and in the permanent vigour which ſucceeds youth, has more conſiſtence and more fibrous matter.

In old age, it loſes part of its energy, its heat, and its plaſtic property, but it becomes more diſpoſed to be detained, and to form concretions of ſeveral kinds.

The blood of the female preſerves for a long time the character of the blood of youth; it has been ſuppoſed, that the uterine and the menſtrual blood have ſome particular qualities, a diſtinct ſmell and vapour which act at a diſtance upon flowers and fruits, upon liquors in the the ſtate of fermentation, the colouring matters, &c. When we ſeparate from this opinion what is erroneous and exaggerated in it, it preſents to the impartial obſerver ſomething true, which ought to be aſcertained by exact experiments, inſtead of denying what has not yet been comprehended.

53. The different orders of animals have certainly differences in their blood, proceeding from thoſe of their nouriſhment, of the digeſtive, reſpiratory, &c. organs. The chemical inveſtigations by which theſe differences are to be aſcertained, have hardly been commenced; we have yet only very few general obſervations upon ſome of the properties of the blood, compared in the different orders of animals.

A. That of the mammalia approaches very near in its nature to that of the human ſpecies; like the latter, it contains a white ſerum, a ſerum coloured by ſuper-oxidated phoſphate of iron, fibrine, muriates of ſoda and pot-aſh, phoſphates of ſoda, and of lime and ſoda, the proportions

portions of which vary in each particular animal, as Rouelle the younger has ſhown, by giving a table of the quantities of ſalts which he had extracted from the blood of the horſe, the bullock, the aſs, the calf, the ſheep, the goat, and the hog. This chemiſt was much aſtoniſhed, that the animals which eat vegetable food, and conſequently pot-aſh, conſtantly preſented free ſoda in their blood; however, it is eaſy to conceive, that the pot-aſh ought to decompoſe the muriate of ſoda. He found no phoſphates in it; for the knowledge of theſe we are indebted to my analyſes made ſince 1780.

B. The blood of birds is in general more red and more hot than that of the mammalia, and very quickly becomes fixed or coagulated; its coagulum is gelatinous; it does not ſeparate from the ſerum except with difficulty. Its colour is never ſo brown or ſo dark as that of the blood of men, and of the mammalia. No comparative analyſis has yet been made of it; we know neither the proportions of its parts, nor the ſalts that are contained in it.

C. The blood of the amphibia, and of the fiſhes, is as little known as that of the birds; no chemiſt has yet examined it; we only know, that it is colder, very little ſuperior to the temperature of the air or the water in which theſe animals live, that it is little concreſcible, and that it appears extremely diſpoſed to become oily.

D. As to the molluſca, the inſects, and the worms, it has been believed, that they have a white or little coloured blood, but no experiments have been made in order to aſcertain the characteriſtic properties of this liquid. However, there exiſts in ſeveral of theſe animals a red blood, analogous in its appearance to that of the preceding. It is needleſs to obſerve, that an exact analyſis and compariſon with that of the kinds of blood already, will throw much light upon the functions of theſe beings.

SECTION IX.

Of the Alterations of which the Blood is ſuſceptible.

54. ONE of the moſt important reſults which medical philoſophy expects from the reſearches of chemiſtry reſpecting the blood, conſiſts in appreciating the changes and alterations in the different morbid affections; but theſe reſearches have ſcarcely been as yet commenced. Citizen Deyeux and Parmentier have juſt begun to examine the blood in ſome diſeaſes. They have found in general that the albumen is the element the moſt altered in this liquid; they have made ſome experi-

ments upon the blood of ſubjects attacked with inflammatory diſeaſes, with ſcurvy, and with putrid fever.

55. The blood, which is called *inflammatory*, taken from pleuritic patients, preſented to them a buffy coat which covered its ſurface, a ſoft coagulum, a coagulation as it were partial, filamentous and interrupted in the heated albumen, the impoſſibility of cauſing it to coagulate in boiling water, and the property of giving it a milky colour. The buffy coat appeared to them to be formed of the fibrin altered, ſoftened, melted into a kind of gelatin, ſoluble in the acids; accordingly the blood upon which it is formed preſents a very ſoft coagulum, which ſcarcely affords any fibrin when it is waſhed, or which diſſolves almoſt entirely in water. We ſee that the inflammatory character of the blood conſiſts in melting, or liquefaction of the fibrous part and of the albuminous matter, inſtead of the thickneſs and coagulation which had been ſuppoſed to exiſt in it, and that the ſubſtances which, in the healthy ſtate, tend to concreſcibility and ſeparation have loſt this property. I do not however conſider it as demonſtrated that the buffy coat proceeds from the fibrin; it appears to me more natural to conſider it as ſuper-oxigenated albumen, which carries with it a portion of fibrin on account of is concreſcible power, whilſt in the natural ſtate it is the fibrin which retains a portion of the albumen.

56. The blood of three ſcorbutic patients, which had been drawn on account of the pain and the plethora which exiſted in theſe perſons, from twenty-nine to forty-ſeven years of age, exhibited to Citizens Deyeux and Parmentier phenomena different from thoſe which had been announced in this liquid. It had neither a greater fluidity than in the ordinary ſtate, nor the abſence of coagulation; it became concrete; its albumen was leſs concreſcible by heat. The coagulum waſhed with water afforded fibrin in elaſtic filaments; upon one of them there was formed a buffy coat, only leſs thick than in the inflammatory blood, and which became friable by deſiccation; the water in which the coagulum had been waſhed, or the colouring part, afforded membranes that floated in it. This blood had not its uſual ſmell: the white ſerum was ſeparated from it in the accuſtomed manner, and was not more abundant than in the ordinary circumſtances. For the reſt, the chemiſts of whom I ſpeak believe that only erroneous inferences can be deduced from the quantity of ſerum ſeparated from the coagulum of the blood. According to them, its ſpontaneous effuſions in the hemorrhages ſo frequent in ſcorbutic patients do not proceed from its fuſion and greater fluidity, but from the weakneſs and relaxation of the veſſels which contain it. There is reaſon to believe, that a want of oxigenation is the principal character of the blood in ſcorbutic patients, and that it is on

this account that this liquid forms the violet ſpots upon the ſkin, and that the ſea ſcurvy begins with a conſiderable degree of corpulence.

57. The blood taken from the product of veneſection at the arm, performed during the firſt days of the attack of putrid fevers, and in ſubjects with whom the ſymptoms manifeſtly indicated this diſeaſe, preſented to them ſometimes a buffy coat, and ſometimes none; the ſerum generally appeared to them difficult to be ſeparated, and adhering very ſtrongly to the coagulum. They found it likewiſe either very marked analogies with that of inflammatory fevers, or nothing particular; they in vain ſought to diſcover in it thoſe ſigns of putridity with which ſo many authors have aſſerted that is tainted in this kind of affections, and to which they have attributed their cauſe. Diſtilled on the water-bath, this blood afforded them no ammonia, as might have been expected; expoſed to a mild temperature, it did not putrefy more rapidly than the blood of a healthy perſon. According to them, therefore, there does not exiſt in it any particular principle of putridity, which has ſo often been ſaid to characterize the diſeaſes of this kind. It is only in the excrementitial liquors that this tendency to ſepticity, and even an incipient putrefaction, appear in putrid fevers: the blood does not partake of this property.

58. The

58. The chemiſts, of whoſe labours I have juſt given an account, have confined themſelves merely to thoſe reſearches, becauſe the Society of Medicine, to whom they have addreſſed their Memoir, had ſpoken only of thoſe affections in the programma of the prize which has been awarded to them. But how many other important queſtions ſtill remain to be treated! how many uſeful problems to be reſolved in this kind of experiments! The blood has a very remarkable character in thoſe purulent diſeaſes, in thoſe great internal ſuppurations in which it appears to be converted ſo eaſily and ſo ſpeedily into pus. Another preſents itſelf, of equal importance to be determined, in chloroſis or the green ſickneſs of young women, whoſe arteries and veins are filled with a liquid ſcarcely ſanguine, of a light roſe colour, and ſometimes white. With dropſical patients it has already been ſeen dry, gluey, viſcous, and brown; it cannot be doubted that it has ſuffered a kind of decompoſition which ſhows itſelf eſpcially by the ſeparation of the ſerum; for the water of hydropic caſes has the greateſt analogy with this humour. The affections in which the ſuper-abundant bile accumulated in its canals, ſeems to diffuſe itſelf into the ſanguineous ſyſtem, as phyſicians have long ſince obſerved, preſent to chemiſts an uſeful opportunity for aſcertaining whether the means of their art will lead to the demonſtration of the

preſence of the bile in the blood. The ſame is to be ſaid of the melaena or morbus niger, of the adipoſe and lacteal cachexies, and of a multitude of other affections in which the blood aſſumes a particular character, which is known by the practical obſerver, and which awaits from chemiſtry a more exact determination, a more poſitive definition, than mere inſpection has hitherto been able to furniſh.

Article III.

Of the Lymph.

1. THE lymph is a white tranſparent liquid, contained and circulating in an order of veſſels very well known at preſent, the extremities of which, opening into all the cavities, ſuck in or abſorb the liquor effuſed by the extreme arterial ramifications, and the trunks of which unite with the reſervoir of Pecquet and the thoracic duct; ſo that the lymph appears to be taken up at the extremities of the arteries, and carried into the veins. This humor is one of the moſt abundant in the body, as the canals which contain it and tranſport it are extremely numerous. Divided into two general layers, the one ſuperficial and the other deep ſeated, they exiſt in all parts of the animal economy, they traverſe all its regions; they wind along its ſurface and between the fibres of the muſcles; they cover, and as it were envelope all the viſcera.

They therefore announce an important function; and the liquid which diſtends their conical cavities ſeparated and contracted from ſpace to ſpace by valves, muſt ſerve for purpoſes both numerous and neceſſary for the ſupport of life.

2. Notwithſtanding all the intereſt which the knowledge of the nature of the lymph muſt poſſeſs for animal phyſics, this knowledge is as yet but very ſuperficial or vague, or even erroneous: no author has occupied himſelf with it in particular; chemical ſcience cannot yet preſent any analyſis of this humour. From Bartholin and Rudbeck, the firſt anatomiſts who diſcovered theſe abſorbent veſſels towards 1650, to the laſt very extenſive and accurate reſearches of Maſcagni and ſome other moderns, every thing has been done for the knowledge of the ſtructure, the number, the diſpoſition, and the courſe of theſe abſorbent veſſels, but nothing has yet been done as to that of the lymph which they convey. Indeed we have not the means of procuring this liquid, as we have of obtaining the blood. Though at preſent the moſt of the abſorbent veſſels have been well deſcribed, and though the courſe of a great number of them are known, we are as yet ignorant of the art of extracting the lymph pure; no *lymph-letting* is performed, whereas blood-letting is performed with great facility.

3. Some circumſtances of chirurgical diſeaſes, however, afford opportunities for making experiments upon the lymph. In wounds and ul-

cerations of the inguinal and popliteal regions, it ſometimes happens that the trunks of abſorbent veſſels are opened, and that the lymph flows out of them in ſuch abundance, that the clothes and dreſſings are very ſtrongly impregnated with it. I recollect having ſeen two ſuch caſes in an hoſpital in Paris; but I was then too young and too little advanced in this kind of reſearches to have derived the advantage from them which they might have afforded me. Similar circumſtances are perhaps not ſo rare as might be believed; and it is to be hoped that thoſe to whom they may hereafter preſent themſelves, will not let them eſcape without availing themſelves of them for the benefit of the art. Perhaps even, if we ſhould direct our views towards this kind of reſearches, we might acquire the art of opening abſorbent veſſels at pleaſure, and by this kind of lymph-letting imitate what is performed in blood-letting. There is even ground to believe that this ſpecies of operation may ſometime fulfil uſeful indications, remedy lymphatic plethora, diminiſh the maſs of ſuper-abundant white and nutritive juices, evacuate this humour accumulated in the cavities: for the depletion of a large lymphatic veſſel, and the vacuum by which it would be followed, muſt augment the force of ſuction and abſorption in one of the regions, and conſequently in the whole continuity of the abſorbent ſyſtem.

4. Whilſt I await the fulfilment of my wiſh, that this idea may ſtrike deeper root in the learned and medical world, I muſt at leaſt collect here what has been ſaid concerning the nature of the lymph. Inſtead of taking this liquid in its own canals, and for want of the humour itſelf which we have not yet been able to extract from its proper reſervoirs, the ſerum of the blood has in ſome reſpect been ſubſtituted in its place, and repreſented as the lymph in moſt works of medicine and phyſiology. Haller himſelf, though otherwiſe ſo exact, and who preferred facts to any hypotheſes, has followed this method. We find it indicated in a great many places of his immortal work, and particularly in the article concerning the ſerum of the blood, and in the ſketch of the chemical claſſification of the humours which precedes his hiſtory of ſecretion. Moſt of the phyſiologiſts who have written ſince him, and who may almoſt all be conſidered as his copiers or plagiaries, have had no other idea. Dehaen, who however has endeavoured in his works to introduce more preciſion into the theory of the humours and of their morbid alterations, has followed this opinion. I know only Bucquet, who, in his Courſe of Lectures, has combated this ſimilitude adopted between the ſerum of the blood and the lymph, and who has inſiſted not to prove that theſe two liquids are not the ſame, for of this we have not acquired any

certainty, but to ſhow, that as long as the lymph ſhall not have been particularly examined, we can have no certainty that it is of the ſame nature as the ſerum, and that we are no leſs authorized to ſuſpect it to be different than to aſſert that it is analogous with it.

5. Haller, where he quotes the anatomical and phyſiological labours of Stenon, Bartholin, Drelincourt, Bellini, Wepfer, Werreyen, and Monro, and calls the lymph ſerum, and the ſerum of the blood lymph, indiſcriminately with theſe celebrated men, ranks the latter humour amongſt the gelatinous; but we ſoon perceive that he gives this name of *gelatinous humours* to thoſe which I call *albuminous*, ſince he indicates at the ſame time the concreſcibility by fire as their diſtinctive character. He therefore announces that the lymph is coagulated by heat, by the acids, by alcohol, that it is ſaline, ſlightly viſcous; that it froths by agitation; that it concretes into ſolid flakes by the action of boiling water; that it is ſoluble in cold water; that it yields by diſtillation a fetid oil and concrete volatile ſalt or carbonate of ammonia; that ſalts are found in ſolution in it: in a word, he compoſes its hiſtory and the totality of its properties of all thoſe which belong to the ſerum of the blood. He makes of it really an albuminous humour; he adds that it renders the oils miſcible with water, and he proves it by the abſorption of the fat effected ſo eaſily and ſometimes ſo ſpeedily by the lym-

phatic veſſels. He even takes care to diſtinguiſh well from this liquor, as from the ſerum of the blood, the mucous humours which anſwer to thoſe which I call *gelatinous*, as he aſſigns to theſe the character of not being coagutable, but on the contrary fuſible by the action of heat, of being very tranſparent and glutinous. Senac, Queſnay, and Dehaen, had already admitted a like diſtinction.

6. Without denying the poſſibility of this identity, or at leaſt of a very ſtrong analogy between the lymph and the ſerum of the blood, which may in fact be conſidered as its firſt ſource, we cannot however avoid two reflections equally juſt and important: the one that there is wanting to the proof of this analogy an analyſis of the lymph taken in its tubes, and compared with that of the ſerum, as Bucquet ſaid; the other, that even admitting the ſerum of the blood to be the only ſource of the lymph, it is natural to conceive that there exiſt in the latter more or leſs conſiderable differences from the albumino-mucous liquor of the blood, ſince the latter muſt, during circulation by ſerving for ſeveral different uſes, paſſing through different organs, furniſhing ſeveral ſecretions, loſing ſome of its principles, have experienced an alteration ſufficiently conſiderable for it no longer to be capable of being conſidered as having exactly preſerved its primitive nature and compoſition.

7. Were we permitted to indulge ourſelves in conjectures founded upon ſome facts which may render them probable, we might believe for example, that by the effects of the fixation of oxigen, of the diſengagement of heat, of the loſs of water, or of hidrogen, and of a portion of its carbon, effects which, having commenced in the lungs, are continued throughout the whole route which the blood takes during its circulation, the blood paſſes gradually into the ſtate of fibrin; that in proportion as this takes place, the albumen which remains without this converſion becomes more oxigenated, more concreſcible, more plaſtic, and that one of its parts diſazoted, diſhidrogenated, and carbonated, forms the animal mucilage or the gelatin. The lymph then, which would be in ſome meaſure the reſiduum of this portion of albumen converted into fibrin, which continues as ſuch, either to conſtitute the blood or to form the muſcles, would contain a portion of highly oxigenated albumen, and a larger quantity of gelatin. Thus the hæmatoſis would terminate by a ſeparation of the blood into three different matters: the one highly azoted, or the fibrin; the ſecond highly oxigenated, or the very concreſcible albumen; and the third highly carbonated, or the gelatin. A portion of the two laſt diſſolved in water would form the lymph, and a portion of the fibrin depoſited with the colouring matter

in the muſcles would ſupport their nutrition and life.

8. But though this conjecture accords well with the knowledge which we have concerning the comparative nature of the three matters which enter into the immediate compoſition of the blood; though we ſee in many chemical operations upon the animal matters a ſort of partition of their primitive homogeneity into two or three different ſubſtances, it will always be merely an hypotheſis till a careful analyſis of the real lymph, compared with that of the ſerum of the blood, ſhall have decided upon the probable difference which exiſts between them, or upon the analogy which has already been ſuppoſed between theſe two liquids. It muſt never be forgotten that our knowledge of the very prompt alterability of the animal liquids renders the difference infinitely more probable than the analogy between theſe two liquids; and that the lymph may very well not be what I have ſuppoſed it, without on that account being in all reſpects ſimilar to the ſerum, as the phyſiologiſts have admitted by a deciſion too precipitate and too little founded upon facts not to be an error.

ARTICLE IV.

Of the Fat, and the Sebacic Acid.

1. THE fat is an animal oil more or leſs fluid and running, or at leaſt ſoft in the living animals, which conſequently ought to be ranked amongſt the liquids. As it is almoſt univerſally diffuſed in all the regions of the bodies of animals, I have placed it in the firſt claſs of their immediate materials. It is lodged in ſmall ſacs formed by the cellular texture; in which it even aſſumes, as in a mould, the form of their interior ſides. Accordingly, we almoſt always find the fat in kinds of lumps or pieces of flat, orbicular or irregularly ſquare figures. When we examine it by the microſcope, we ſee it formed of veſicles filled with a tranſparent humour. Wolf has compared the fats of ſeveral animals in this point of view. In diſſections and when the vital heat is extinct, we find the fat more or leſs ſolid; but the ſoftening which it undergoes between the fingers is of itſelf ſufficient to prove that it is liquid and running in the organs of living animals; beſides, many anatomiſts have ſeen it, on opening the bodies of living animals, in a real ſtate of fluidity.

2. The fat has a ſweet and faint taſte, a very ſlight odour when it is hot, a ſpecific weight

inferior to that of water, at the top of which it floats. Its taſte is ſometimes a little acrid, and its ſmell rather ſtrong in ſome kinds of animals, eſpecially in thoſe whoſe muſcles are black and which naturally uſe violent exerciſe. Though its colour is in general pretty white, it however varies from the greyiſh white to a more or leſs orange-yellow, greeniſh or reddiſh colour throughout the whole ſcale of animals. The ſame is the caſe with its conſiſtence, which extends from the fluidity of an oil to an unctious ſoftneſs in theſe beings whilſt living, and from this ſoftneſs to a dry and brittle denſity after death and after the ceſſation of the vital heat.

3. The fat is found abundantly diffuſed under the ſkin, where it forms immediately under the cutis a more or leſs thick integument. There is much of it at the ſurface of the muſcles between the intervals of the different ſpecies of theſe organs and in the interſtices of their fleſhy faſciæ. We alſo meet with a remarkable quantity of it round ſome parts of the articulations, in the ball of the eye where it envelopes the muſcles along the veſſels of the neck, in the mediaſtinum and at the baſe of the heart, round the ſtomach and the inteſtines. It is eſpecially in the vicinity of the kidneys and in the membraneous duplicature of the epiploon that it is accumulated in great abundance. If there be little of it round ſome of the muſcles which are conſtantly in motion, there is on the contrary a

conſiderable proportion of it upon the large muſcles of the abdomen, and on the outer part of the buttocks which it partly cauſes to project in the human ſpecies, whilſt no animal preſents this protuberance of the buttocks. It is alſo abundant upon the breaſt, round the mammary glands in women, in whom it determines the prominent, rounded and graceful form of the boſom. The folds of the great articulations alſo preſent a remarkable redundance of it, as well as the palms of the hands, the ſoles of the feet, the tendinous extremities, mucous bags or capſules deſtined for facilitating the ſliding of the tendons. There are very few animals which preſent any in their brain, upon the forehead, upon the cartilages of the noſtrils, of the ears, round the lungs, or the penis ; it conſtitutes in general the twentieth part of the weight of a man. Its quantity varies according to the different animals and according to a multitude of circumſtances.

4. Some anatomiſts have admitted particular organs for the formation of the fat. Malpighi, in deſcribing the adipoſe glands, believed that there exiſted alſo veſſels for conveying it into the different parts ; but neither the one nor the other of theſe organs have been ſeen and confirmed ſince him. It is generally believed, with Haller, that the fat is ſeparated from the blood in the arteries ; that being formed in theſe veſſels it is carried by its ſpecific lightneſs to the circumference of the ſanguineous cylinder which

diſtends the arteries, and puſhed through ſmall orifices, with which their ſides are ſuppoſed to be perforated, into the cells of the mucous texture. In order to prove this opinion, Haller lays great ſtreſs upon the phenomena of injections which exude through all the lateral points of the arteries; he adduces that the fat frequently exhibits points and a red tinge of blood extravaſated through the ſides of arteries after animals have been violently hunted; that Morgagni has ſeen fat run in drops from divided veſſels; that Malphigi aſſerts that he has ſeen it in the arterial and circulating blood of frogs, and that Gliſſon and Ruyſch have diſcovered it in the blood of ſcorbutic patients. Reſt, abundant nutrition, diminution of the ſecretions, and eſpecially of perſpiration, the debility and relaxation which follows hærmorrhages, caſtration, are the circumſtances which favour its formation. A marked diſoxigenation in the blood is its primitive ſource, according to the principles of the French pneumatic chemiſtry, ſo well applied by Dr. Beddoes. We ſee birds become fat during a fog of ſome hours continuance, (qu.) eſpecially ortolans, robin red-breaſts, thruſhes, &c. The abſorbent veſſels ſuck it up and cauſe it quickly to diſappear in the animals that ſleep during the winter, or in fibrile diſeaſes, in great ſuppurations, during violent exerciſe, in conſequence of the uſe of acrid food the abuſe of vinous or ſpirituous liquors, mercurial frictions, &c.

5. The chemical nature of fat was not known till within a few years paſt. Olaus Borrichius was the firſt who paid particular attention in the ſeventeenth century, to the acrid and ſtrong ſmoke which is diſengaged from this ſubſtance when ſtrongly heated, and deſcribed the bad effects which it produces upon perſons who expoſe themſelves to it. In 1740, Grutſmacher, from the action of the powerful acids upon the vegetable oils, conſidered fat as an oil thickened by an acid. His opinion was followed by all the chemiſts down to our own time. Grutſmacher occupied himſelf with this acid of fat in 1748. Rhades, having been engaged in the inveſtigation of animal matters by the inſtances of the celebrated Haller gave ſome details relative to this humour in a Treatiſe publiſhed at Gottengen in 1753. Knape conſidered this acid when rectified as very ſtrong and forming a particular ſpecies. A year after the inveſtigations of Rhades, Leyner gave an account of a ſeries of experiments upon the acid of fat, upon which he publiſhed a particular diſſertation. However, notwithſtanding theſe preliminary labours, D'Aumont did not heſitate to deny, in the firſt edition of the Encyclopedia, the preſence of an acid in the diſtillation of fat. Haller re-eſtabliſhed the truth in the ſupplements which he added ſome years afterwards to the medical articles of that work. Crell, in 1779, publiſhed a long Diſſertation and an extenſive ſeries of experiments upon fat and its acid; he ſhowed

how to extract and purify it; he deſcribed its diſtinctive properties and its ſaline combinations. Since him, all the chemiſts have confirmed as well as extended the reſults of Crell upon the acid extracted from fat. Maret, in the academical courſes at Dijon, repeated his experiments and added ſome facts to them. Citizen Guyton has publiſhed an accurate hiſtory of them in the firſt volume of the *Encyclopédie methodique*, or that in which the order of the ſubjects is followed; he there eſpecially maintains the exiſtence of this acid ready formed in the fats. Citizen Berthollet has proved the preſence of oxigen in them, and has ably deſcribed the mode of their action upon the metallic oxides. I have alſo occupied myſelf with the chemical properties of this animal compound; I have found that the ſebacic acid does not exiſt in it ready formed, but that it requires the decompoſing action of fire in order to obtain it; I have ſhown that the nitric acid oxigenates fat and renders it capable of acting in a very remarkable manner upon the animal economy. It is ſince this period that it has been employed with ſucceſs in the itch, in inveterate herpetic eruptions, cutaneous ſyphilitic ſymptoms, &c. I have diſcovered the poſſibility of explaining its formation, its fuſion, &c. by the chemical attractions and the ſtate of the blood in living animals: finally, I have determined the difference of ſome ſpecies of fat.

6. The firſt experiment, or firſt proceſs which is practiſed upon fat, conſiſts in its purification. It is known that this humour, ſuch as it is, extracted from the body of animals, is mixed with cellular texture and with lymphatic veſſels, with blood and with gelatinous mucilage; that it is very ſuſceptible of alteration: In order to purify and preſerve it, it is cut into ſmall fragments; the moſt apparent and the largeſt membranes and veſſels are ſeparated from it; it is carefully waſhed, with much compreſſion, in a large quantity of water; it is even triturated with water in a mortar; it is melted in a veſſel of porcelain or pottery with a ſmall quantity of water; this is ſuffered to be diſſipated till the crackling noiſe which indicates its paſſage through the fuſed fat and its evaporation into the air is no longer heard; it is carefully ſcummed in order to ſeparate from it portions of the ſolid parts which may remain in it; it is poured into a cold and new veſſel, in which it becomes fixed in a white, granulated and cryſtalline maſs, very ſmooth, ſoft, and fuſible between the fingers, which keeps for a great length of time. This operation is principally performed in the laboratories of Pharmacy and the perfumers' work-ſhops with the fat of pork, which is in this ſtate called lard or *axungia*. The fat thus purified is more opaque, leſs denſe, and much whiter than in its natural ſtate: it retains between its molecules a certain quantity of water which gives it theſe new characters.

7. Fat expoſed to a mild fire is liquified, becomes tranſparent, and fixes into ſmall, cloſe and granulated cryſtals by cooling. Its fuſion takes place between forty and ſeventy degrees of the centigradal thermometer, according to the different varieties of this animal matter. It may be melted in balneo mariæ, in order to avoid its alteration when we wiſh only to effect its fuſion. Heated in contact with the air beyond the heat requiſite for fuſing it, it quickly acquires a temperature ſuperior to that of boiling water; it becomes capable of baking and drying the vegetable and animal matters that are immerſed in it, which are drawn out of it hardened at their ſurface and deprived of water. Soon afterwards there ariſes from it acrid and pungent vapours, which excite a diſcharge of tears, and irritate the fauces. This ſmoke inflames, and the fat continues to burn till it is reduced into coal. We ſee by this that it does not burn till after it has been volatilized, and that it is in order to reduce it into vapour that, when it is employed for lamps, a wick is uſed for the purpoſe of conveying into the air the part which has been reduced to vapour.

Fat diſtilled on the water-bath affords a certain quantity of water of a faint ſmell, in which the different re-agents produce no alteration, and which nevertheleſs becomes turbid, depoſits flakes, and acquires a fetid odour when it is kept. This water, however, preſents a leſs ſenſible alteration than moſt of the other animal ſubſtances; it becomes leſs ammoniacal; and it is in general a very marked character of this ſpecies of humour; that it affords much leſs of the latter product than all the other animal compounds; which has induced chemiſts hitherto to ſay that it was an almoſt vegetable matter, or which paſſed almoſt without change from the vegetable aliment into the body of animals. The water which is obtained in this diſtillation of fat on the water-bath was not intirely contained in this humour; a part is formed at the expenſe of the hidrogen and of the oxigen which it contains: on which account, after this mode of action of the fire, the far is perceptibly drier, and of a fawn-yellow or browniſh colour, which announces its commenced decompoſition and the precipitation of the carbon.

8. When we diſtil fat in a retort, we effect its decompoſition in a much more complete manner. This operation has long been performed in the laboratories of chemiſtry: nevertheleſs its real mechaniſm and remarkable phenomena have hitherto been unknown. It has been obſerved, that in this diſtillation the fat paſſed almoſt intire into the receiver when it was heated a little ſtrongly; but there was however diſengaged a ſmall quantity of very acid water, an elaſtic fluid, which Hales reckons to amount to eighteen times the volume of the fat, which was believed to be air, and that there remained a coally mark in the retort. It

has been ſeen, that by repeated diſtillations of the ſublimed fat, there was each time obtained from it a portion of acid water, an oil which gradually became attenuated, a portion of air, and a light layer of coal: it was thence concluded that by repeating this operation the fat would be converted into the ſtate of water and of air. It reſults from theſe facts, which are now better underſtood, that it is into water and carbonic acid, beſides a ſmall quantity of ammonia, that the fat is reduced completely, and in its laſt analyſis; but that in order to arrive at this complete decompoſition, it is neceſſary to add to this matter when heated a large quantity of oxigen; that it is on this account that the operation advances much faſter in a large veſſel than in a ſmall one, or that we are obliged to repeat the diſtillation a great number of times in ſucceſſion; finally, that this decompoſition reſembles, though in another mode and with other phenomena, the combuſtion of the fat in open veſſels; that when this is performed with care, we have only water and carbonic acid as products; that when it is effected only in part we obtain from it, as in diſtillation, an acid vapour, a portion of oil not decompoſed, but merely volatilized, and a coally, or fungiform concretion of coal, which collects upon the wick, and preſent a new obſtacle to this phenomenon; that thus the products of the diſtillation of the fat in the retort, the phlegm, the ſebacic acid, the gaſes, the more or leſs liquid oil, are kinds of compounds intermediate between this body and the water, and carbonic acid, which are the ultimate terms of its decompoſition; that their proportion muſt vary according to the force of the decompoſition that is effected, according to the temperature that is employed, the ſize of the veſſels, the quantity of air which they contain, the manner in which the fire is managed, &c.

9. Theſe general notions ſerve to enable us alſo to conceive and explain what the different chemiſts have written concerning the diſtillation of fat. Neuman, one of the firſt who has well deſcribed this operation, diſtilled comparatively the fats of the bullock, the ſheep, the hog, and the gooſe: he employed 1152 parts (grains) or two ounces of each of theſe fats. That of the bullock gave him ſixty parts of phlegm or empyreumatic and acrid liquor, of which he has not however indicated the acid nature, 852 parts of oil, and eighteen of coal. From the fat of ſheep he obtained ninety parts of phlegm, 854 of oil, and 16 of coal; from that of the hog, 70 parts of phlegm and 880 of oil; and from the fat of the gooſe, 60 parts of empyreumatic water, 890 of acrid oil, and 10 of coal. He conſidered this coal as earth: he took no account of the elaſtic fluids, and he did not know the ſebacic acid. Hoffmann believed that the product of the diſtillation of fat was alkaline, as it turned copper

blue. Segner obtained from four ounces of human fat, heated to 600 degrees of Fahrenheit's thermometer, or 270 of Reaumur, 100 drops of phlegm, the acidity of which he has indicated, as well as Vogel; he has obſerved that this product reddened the blue colour of violets, that its ſtrong odour was obnoxious to the brain: that there remained in the retort, after he had obtained it, a concrete and blackiſh oil.

Crell performed the diſtillation of the human fat in a more careful manner: twenty-eight ounces, heated in a glaſs retort with the ſand-bath, yielded, after having melted at the 115th degree of Reaumur's thermometer, an inſipid phlegm; at 220 degrees, an inflation took place, which did not appear in the fat of the bullock; there were diſengaged two liquids, a brown and liquid oil upon a water of a gold-yellow colour, beſides an oil fixed at the bottom of this water. The operation laſted twenty-one hours: all the products had a ſtrong ſmell. By diſtilling them over again, he obtained twenty ounces, five drachms, forty grains of fluid oil; three ounces, three drachms, thirty grains of acid phlegm; three ounces, one drachm, forty grains of brilliant coal, five drachms, ten grains loſs.

We eaſily perceive, in the differences of the proportions between theſe different analyſes, the truth of what I have advanced concerning the varieties of the mode of operating, of the temperature,

perature, of the form and ſize of the veſſels, concerning the rapidity with which the heat is applied, the repetition of the diſtillations, &c.

10. Fat kept in the air becomes the more altered in it the more multiplied the points of contact between them are, and the hotter the atmoſphere is; it acquires a yellow and ſometimes an orange colour; it aſſumes a pungent odour, which is known by the name of a *rancid ſmell*, with an acrid and manifeſtly ſour taſte. This kind of rancidity, which is owing to the development of an acid, ſuppoſes alſo the fixation of a portion of oxigen; it appears that it proceeds from a fermentation which eſtabliſhes itſelf in the gelatinous ſubſtance, which accompanies even the purified fat, which re-acts upon the adipoſe ſubſtance itſelf, which developes in the latter ſebacic acid, and perhaps a ſmall quantity of acetous acid in the firſt. The water in which rancid fat is waſhed acquires an acrid taſte, and the property of reddening the blue vegetable colours. Mr. Poerner employed this liquid in order to purify it. Alcohol equally poſſeſſes this property, according to Citizen Machy. However, both of theſe agents diſſolve a part of the fat at the ſame time with its acid, and the fat, though well waſhed, retains a portion of the latter. Theſe obſervations already prove that the ſebacic acid, developed in the ranceſcence of the fat, was not contained ready formed in this ſubſtance, but that it is formed by the fermentation itſelf

which it has undergone. However little rancid the fat may be, we ſee that it acquires properties very different from thoſe which it poſſeſſed previous to this rancidity, and which it muſt however have in part, at leaſt, if it naturally contained ſebacic acid ready formed.

11. Fat mixes very well with ſulphur by ſimple trituration; it diſſolves it with the aid of fuſion, and aſſumes a pretty ſtrong conſiſtence by this union, which forms the ſulphurated ointment. When we heat this ſulphurated fat, we do not obtain from it any ſublimed fat, but a large quantity of ſulphurated hidrogen gas and of ſulphureous acid, becauſe a high temperature, by favouring the decompoſition of the fat, transfers a portion of its oxigen to the ſulphur, which it burns in part, and of its hidrogen to the ſame body which it carries off in the gaſeous form.

The caſe is the ſame with phoſphorus, which is diſſolved very eaſily in the heat by melted fat. It is difficult to ſeparate the phoſphorus from this combination: it is, however, not ſo much fixed in it as the ſulphur; but it is alſo diſengaged from it by the action of heat in the ſtate of phoſphorated hidrogen gas. In performing this experiment, it is neceſſary to employ precautions in order to prevent the detonation and ſudden inflammation which may be produced by the phoſporated compound.

Fat acts even in the cold upon ſome metals, the oxidation of which it effects, or at leaſt favours, when it is triturated with theſe bodies reduced into ſmall particles, and in contact with the air. This effect is particularly perceptible in the preparation of the mercurial ointment, which conſiſts in triturating running mercury with hog's lard. We ſee this metal gradually loſe its metallic form and liquidity, and the fat acquire a black colour. Though in this extinction it was at firſt thought that the mercury was only divided, as we always ſee metallic globules in the beſt prepared ointment, it is certain that it is a real black oxidation of the metal, becauſe it takes place much more ſpeedily when we add to the fat red oxide of mercury, ſuper-oxigenated muriate of mercury, or when, inſtead of ſimple lard, we take oxigenated fat, as I ſhall indicate hereafter, when we aid this extinction by highly oxigenated animal matters, ſuch as ſaliva. The fat acts in the ſame manner upon copper, which it very quickly converts into green oxide. This phenomenon is very perceptible with wax, which indeed is one of the moſt highly oxigenated adipoſe ſubſtances.

12. Water does not diſſolve fat, and when we employ it in order to waſh and purify it, it is only in order to ſeparate from the blood and other ſoluble matters which it contains. When fat is boiled in water it melts, and the aqueous liquor then diſſolves the membranous laminæ, and the cellular texture which are interpoſed in it; ſo that if the water be in ſmall quantity,

and we afterwards ſuffer it to cool, it concretes into a jelly. I have already ſaid, that a portion of this liquid is interpoſed between the molecules of the fat: ſo that after the cooling and condenſation of the latter, it is in a granulated form, more light, white, and opaque than it was before. It is neceſſary to heat it afterwards for a long time, in order to ſeparate from it this portion of water, which eſcapes with a crackling noiſe till the laſt particle. Another effect is produced by the water when the fat is boiling and violently heated, when it is on the point of being inflamed, and eſpecially when it is ſo already. Water thrown upon fat thus heated frequently produces a conſiderable exploſion, and greatly augments its inflammation, which is owing to a real decompoſition of the water effected by the red-hot carbon, and the rapid diſengagement of the carbonic acid, and of the hidrogen gas, which are the product of this decompoſition. On this account water, ſo far from being able to ſtop the burning of inflamed oils and fats, only gives greater activity to the combuſtion, and augments its ravages,

13. Fat acts with the aid of heat, upon all the metallic oxides, and reduces them at firſt by becoming itſelf oxigenated, and afterwards by being decompoſed. This effect is obſerved in the preparation of ointments and plaſters. It is the ſame as that which I have deſcribed in the hiſtory of the oils. Many metallic

oxides, eſpecially thoſe of lead, copper, and iron, are ſoluble in hot fat; they give it conſiſtence and heat; they form with it kinds of inſoluble ſoaps; it is therefore dangerous to melt fat in earthen veſſels glazed with the oxides of lead and of copper.

The powerful acids, and eſpecially the ſulphuric and the nitric, act in a very remarkable manner upon fat, whilſt the weak and little decompoſable acids, or thoſe which yield their oxigen with difficulty, do not cauſe it to undergo any alteration.

The concentrated ſulphuric acid turns fat brown, and reduces it to coal in a perceptible manner in the cold: its action ſtops when it has formed in it a ſufficient quantity of water to be ſaturated with it. In the heat it goes much farther; there are diſengaged ſulphurous acid gas, carbonic acid gas, and ſulphurated hidrogen gas. The fat is afterwards in a great meaſure decompoſed, and there remains of it only a ſmall black portion having little conſiſtence.

The nitric acid acts but very little in the cold upon the adipoſe compound. In the heat, at the temperature at which the fat melts, nitric acid, at 32 degrees of the aërometer, is decompoſed, yields oxigen to it, gives it an orange-yellow colour; there is diſengaged a ſmall quantity of nitrous gas, and azotic gas; it is in this manner that we obtain the oxigenated ointment, which I firſt propoſed ſeveral years ago, to be ſubſtituted inſtead of the unguentum citrinum, and which Citizen Alyon has ſince found ſo uſeful in the itch, in old herpetic eruptions, and in venereal affections of the ſkin. He prepares it by taking fifteen parts of fat, and one part of the acid indicated, by cauſing them to act at a mild heat till an ebullition takes place, by withdrawing the mixture from the fire, and by agitating it conſiderably whilſt it is cooling. There may be many degrees of the oxigenation of the fat, according to the form and the quantity of the acid which is employed. If we employ three or four parts of nitrous acid to one of fat, and heat it ſtrongly, we decompoſe theſe two bodies; the fat becomes ſenſibly brown, ſebacic acid and a little oxalic acid are formed, whilſt much nitrous gas and carbonic acid are diſengaged, without mentioning the water which is diſengaged at the ſame time. Amongſt the different oxidations which the fat is made to undergo by treating it by this acid, of different ſtrengths, at different temperatures, and in varied doſes, there is one which approaches ſo near to the dryneſs of wax, that there is reaſon to hope we ſhall at ſome future period, be able to give it this character in our manufactures. The fat oxigenated to the ſtate of ointment or pomatum extinguiſhes mercury five times faſter than natural fat, and may ſerve with great advantage for the preparation of the *unguentum citrinum:* it is alſo ſuſceptible of quickly oxiding copper, which it diſſolves with the aid of heat, and with which it ſoon forms a ſort of brown ointment; it is ſoluble in alcohol, &c. We may oxigenate fat by means of the oxigenated muriatic acid.

14. The cauſtic alkalis have a very ſtrong action upon fat; they eaſily reduce it to the ſaponaceous ſtate. This kind of animal ſoap may ſerve for all the purpoſes of economy, and it is manufactured of this kind in ſome countries. Ammonia does not exert any ſuch action upon the adipoſe compound. Lime, barites, and ſtrontian, combine with it, and conſtitute earthy, hard, ſolid, and inſoluble ſoaps. Theſe compoſitions are ſometimes employed in the fabrication of mortars or cements, and they give them a conſiderable ſolidity, and the property of receiving a ſoft and unctuous poliſh. The ſoaps of fat, when burned by a violent fire, are reduced to coal and afford alkaline and earthy ſebates, which ſome modern chemiſts have believed to be all formed in the original ſoaps, but which are really formed only by the high temperature which burn and decompoſes the fat. I ſhall ſoon ſpeak of them again in treating of the ſebacic acid. The ſalts have no action that is known upon fat; the muriate of ſoda preſerves it, and keeps it for a conſiderable length of time from becoming rancid.

15. The metallic ſalts and ſolutions exerciſe in the heat upon melted fat, an action which has long been known in the laboratories of pharmacy, where ſeveral compoſitions of ointments or plaſters, are prepared with theſe matters: it is eſpecially exemplified with the nitrate of

mercury in ſolution. When we pour this ſolution into melted fat, and agitate the liquid, there is ſuddenly formed a yellow precipitate, and the mixture, as it cools, aſſumes a ſolid conſiſtence, preſerving its colour; on which account it has been called the citron-ointment. The oxide of mercury in this compoſition quits the nitric acid, and paſſes into the ſtate of yellow oxide; the fat is oxigenated by the acid, and itſelf aſſumes a ſimilar tinge. We ſee azotic gas diſengaged in ſmall bubbles. All the metallic nitrates, and moſt of the ſalts and acid ſolutions of the metals, preſent either a ſolution or a decompoſition by melted fat. Several of them even unite well with it in the cold and by ſimple trituration. This kind of combination which as yet is little known, and the reciprocal action which accompanies it, deſerve to engage the attention of the chemiſts, and muſt afford, by new reſearches, uſeful matters to the arts, as well as new reſults to the theory of the ſcience.

16. Fat combines with a great number of vegetable and animal ſubſtances: it eaſily diſſolves the extracts, the green colouring parts, the balſams, the reſins, and the gum-reſins, as we ſee in the preparation of a multitude of ointments and plaiſters; it obſtinately retains all the odorous materials of thoſe bodies, as is proved in the art of perfumery; it ſtops the alteration of which theſe ſubſtances are ſuſceptible and preſerves them for a great length of

time; it unites with elaſtic reſin though with difficulty. Alcohol has no action upon it, at leaſt unleſs it be rancid or oxigenated; however, ſome ſpecies of adipoſe ſubſtances, amongſt thoſe which naturally contain the moſt oxigen are capable of diſſolving in it. The mucilages combine with melted fat, and communicate to it that kind of ſoftneſs and unctuoſity which characterizes ſome ointments. The gums triturated with fat render it ſoluble, or at leaſt capable of remaining ſuſpended in water. It is capable of uniting by fuſion with the oils, to which it communicates a part of its conſiſtence. Tannin appears alſo to be ſuſceptible of combining with fat, though this kind of combination has not yet been ſpoken of. Finally, the albuminous animal liquors unite alſo with it by long trituration, and it is through their mediation that the fat is taken up again by the abſorbent veſſels and carried back into the circulation. Haller has obſerved that ſome purulent humours, which are only a compound analogous to thoſe which I here indicate, have the fatty character and inflame when they are heated.

17. I have announced, in ſeveral of the preceding articles, that fat affords, by its decompoſition by fire, a particular acid, which has been called *ſebacic acid*, as it is obtained in conſiderable abundance from tallow. This product deſerves a particular deſcription. Crell has occupied himſelf the moſt with this ſubject of all the chemiſts. After having found that

it was conſtantly diſengaged during the decompoſition of fats by fire, he endeavoured to find the means of purifying it; but he met with great difficulty to ſeparate the oil which accompanies it. Having employed diſtillation with the view to concentrate it, he obtained a very acid water, and was convinced that it was more volatile than this liquid. He ſaturated the acid product of fat with pot-aſh, evaporated the liquor to dryneſs, and heated the reſiduum in a crucible till it afforded no more ſmoke; and till it diſſolved without colour, by precipitating carbon during its ſolution in water. This ſecond ſolution being evaporated afforded him a foliated ſalt which he diſtilled with half its weight of ſulphuric acid, and he thus obtained a fuming acrid acid, in the proportion of one-twentieth part of the ſalt employed. When this ſalt had not been ſufficiently calcined it gave him by the ſulphuric acid an oily liquid of a gold-yellow colour mixed with the acid liquid. He employed an ordinary copper alembic for diſtilling the fat and obtaining from it the acid liquid, as well as the fluid oil; but this proceſs did not anſwer his purpoſe; the acid retained copper, and the tinning of the capital was melted; he therefore endeavoured to find another proceſs than the diſtillation and the ſaturation of the product of the fat by the fixed alkali in order to procure the ſebacic acid. The following is that which he adopted after many attempts.

18. Perſuaded, with all the chemiſts, and eſpecially Cartheuſer, Macquer, &c. that the ſebacic acid exiſted ready formed in fat, he propoſed to fix it by means of the alkalis immediately and independent of diſtillation. He made a ſoap of fat with pot-aſh, of which he mixed ten pounds in a gelatinous ſtate with 22 ounces of diſſolved alum; by ſeparating the liquor from the precipitate formed by the inſoluble aluminous ſoap, and evaporating it, he extracted from it twenty one ounces of ſebate of pot-aſh, mixed with ſulphate of the ſame baſe. It was from this ſalt diſtilled with the ſulphuric acid that he extracted the ſebacic acid; he rectified it upon a quarter of the ſalt preſerved for this purpoſe. He aſſured himſelf that this rectified acid contained no ſulphuric acid by trying it with the acetite of lead; the precipitate which he obtained ought to diſſolve entirely in vinegar if it was only ſebate of lead, and not diſſolve intirely in it if it were mixed with ſulphate of lead.

Citizen Guyton has deſcribed another more eaſy and more ſimple means for obtaining the ſebacic acid. This means conſiſts in treating the fat with quick lime, by mixing this cauſtic earth in powder with melted fat; the mixture is left to cool, the ſoap is waſhed with a large quantity of water, the ley is filtrated and evaporated; the brown calcareous ſebate which is the product is ſtrongly calcined in a crucible, then lixiviated, the ſolution filtrated, the ſuper-abundant lime is ſeparated from it by the carbonic acid, and it is afterwards evaporated by diſtilling the white and pure calcareous ſebate which it affords with ſulphuric acid, pure ſebacic acid is obtained. It appears evident to me, thathere, as in all the proceeding caſes, the ſebacic acid is the product of the great alteration which the fat ſuffers from the fire, that it is not contained ready formed in the fat, and that the calcinations to which the alkalis and the lime, as well as the fat, are ſubjected, when under pretence of purifying the ſalt it is very briſkly heated, are the true cauſes and at the ſame time the proofs of the formation of the ſebacic acid. In my opinion it is neither a ſebate of pot-aſh nor a ſebate of lime: it is not a ſalt but a real adipoſe ſoap which is heated, and which then leaving the animal oil to be decompoſed, preſents the earthy or alkaline ſubſtance to abſorb and fix the portion of ſebacic acid which is formed. No fact proves that pure fat contains this acid; it is only by a conjectural theory that it is admitted, whilſt on the contrary, every thing proves that in order to prepare it, it is neceſſary to decompoſe the fat and combine its conſtituent principles in another order.

19. Crell extracted ſebacic acid to the amount of a little leſs than one fourth of the fat, by treating it according to the proceſs that has been deſcribed. By examining this acid by different means, he began to imagine that it was the ſame

as the muriatic, becauſe it had given him with ſoda a ſalt fuſible without decompoſition by fire, and it acts upon gold with the aid of the nitric acid, precipitates the nitrate of ſilver, ſublimes with mercury, and its ſolution is not decompoſed by the muriate of ſoda, and becauſe its combination with antimony is precipitated by water. But Citizen Guyton on comparing this ſebacic acid with the muriatic acid under other relations, has found more differences than reſemblances between them; he has beſides judiciouſly obſerved, that a ſingle chemical property conſtitutes a ſufficient difference between them to prevent their ever being confounded together. According to him, the ſebacic acid combined with ſoda cryſtallizes in needles, not in cubes like the muriate of ſoda; it forms no deliqueſcent ſalt with iron; it attacks running mercury; it precipitates the oxigenated muriate of mercury, as well as the muriate of ſoda, the baſe of which it retains whilſt it diſengages its acid by diſtillation; laſtly, alum is not decompoſed by the ſebate of lime, which is alſo one of the moſt diſtinguiſhing characters of this acid. According to theſe principal differences, Citizen Guyton does not heſitate to conſider it as a particular acid different from all thoſe that are hitherto known.

20. The ſebacic acid appears to be formed generally by the decompoſition of all the oily bodies, ſince Mr. Crell obtained it by diſtilling butter of Cacao; however it is more eaſily

and more abundantly produced by all the fats; thus the German chemiſt whom I have mentioned has extracted it eſpecially from ſpermaceti. Though the intimate nature of the ſebacic acid, has not yet been determined, what we known of its formation permit us to ſuſpect that it is not, like the Pruſſic and zoonic acids, a real animal product, or compound of a triple radical of hidrogen, carbon and azote, all united with oxigen. Of whatever nature it may be, the following are properties which diſtinguiſh and characterize it. It has an acrid ſuffocating odour, which irritates the eyes, the noſtrils and the throat, by which it is eaſily recognizable. It exhales a white vapour or ſmoke when it is well concentrated; it reſembles in its conſiſtence and aſpect an oily liquor, whence its origin is rendered apparent to the eye. It ſtrongly reddens the tincture of turnſole, and perceptibly even that of violets. It is very volatile, aſſumes a reddiſh colour by the action of fire, and leaves at each diſtillation employed for rectifying it, a brown liquid, or a coally trace when the operation is carried on to dryneſs. It is entirely decompoſed in a red hot tube, and converted into water, carbonic acid, carbonated hidrogen gas and coal.

21. Its combinations with the alkaline and earthy baſes, or the ſebates, have traits of reſemblance with the acetites according to Bergman; Citizen Guyton however obſerves, that they are more fixed in the fire and leſs

alterable by the air. The ſpecies of theſe ſalts have not yet been well deſcribed; we only know that moſt of them are cryſtallizable in laminæ, conſiderably ſoluble, decompoſable by the ſulphuric acid; it alſo appears that the order of the attractions of the ſebacic acid for the baſes, preſents ſucceſſively barites, pot-aſh, ſoda, ſtrontian, lime, magneſia, glucine, alumine and zircon, like moſt of the powerful acids, eſpecially the ſulphuric, nitric and muriatic. Some remarkable facts have been collected relative to the attractions of ſeveral of the ſebates. The ſolution of ſebate of lime does not render that of alum turbid, which proceeds from the weak attraction of the ſebacic acid for alumine. This acid, diſtilled with the alkaline ſulphates, diſengages from them ſulphureous acid whilſt it becomes decompoſed. It precipitates the ſolution of tartrite of pot-aſh in tartareous acidule. It decompoſes the nitrate and the acetite of pot-aſh by diſtillation, but it does not attack the muriate of ſoda. It appears to be capable of attacking glaſs and diſſolving a part of it, as it deprives the veſſels in which it is diſtilled of their poliſh, and afterwards depoſits by digeſtion ſiliceous earth. The ſame effect has been ſeen in the pyromucous acids.

22. The ſebacic acid exerts a ſufficiently marked action upon many metallic ſubſtances. Diſtilled upon the arſenious acid it reduces it into metal, as is alſo done by the entire oil and

fat. It does not attack either cobalt, biſmuth or nickel, even by long continued digeſtion. It precipitates the nitro-muriatic ſolution of antimony, which in fact is decompoſed by water alone in very large quantity. It combines with mercury and ſilver, when it is brought to act upon theſe two bodies in the metallic ſtate. The ſebate of ſilver is precipitated by the muriatic acids, whereas the ſebacic acid decompoſes the nitrates of mercury and of ſilver, the ſulphate of the latter, and even precipitates the ſolution of oxigenated muriate of mercury in a white powder. It equally precipitates the nitrate and acetite of lead, but not the ſulphates and nitrates of zinc, of iron and of copper. It attacks gold very feebly, but it diſſolves it very well when it is combined with the nitric acid. This is one of the facts which chiefly led Mr. Crell to infer a great analogy between this acid and the muriatic. Combined with the oxide of gold, the ſebacic acid forms a cryſtallizable ſalt, as well as with the oxide of platina; it precipitates both from their nitro-muriatic ſolutions.

The German chemiſt, diſpoſed according to all his experiments, to rank the ſebacic acid amongſt the moſt powerful of theſe bodies, announces that it acts even upon the oils, which appears to depend upon its oily nature, and that he has ſucceeded in obtaining ether by treating alcohol with this acid.

23. I have deſcribed all the known chemical

properties of fat in general; I muſt now give an account of the differences which it preſents, as well with reſpect to the different regions which it occupies in the ſame animal, as with reſpect to the age of the animal, the different orders of animals, and laſtly, in its morbid alterations.

The variety of the characters which fat preſents, according to the different regions in which it is conſidered, is a fact well known to anatomiſts. It is more ſolid under the ſkin and in the vicinity of the kidneys; it is leſs ſo, and it even runs like an oil, between the muſcular fibres, or in the vicinity of the moveable viſcera, ſuch as the heart, the ſtomach and the inteſtines. It has a granulated character round the articulations, and in the interior of the corticular capſules. Haller has found it almoſt as hard as a calculus, or what is ſo improperly called a *ſtone of the bladder*, within the leg and along the internal oſſeous ſurface of the tibia.

24. Age cauſes the fat to vary very ſenſibly. Haller found none of it in the epiploon of a fœtus of four months. According to Ruyſch and Diemerbroeck, inſtead of real fat, there is only a kind of tremulous and gluey jelly under the ſkin of the fœtus; afterwards there is formed a ſmall quantity of granulated fat. This humour augments rapidly after birth; in the firſt year of life the human body is extremely fat; the fat under the ſkin is for a long time white; it grows yellow with age: it is ex-

tremely ſoft in the female ſex. At the age of forty years, its quantity exceeds that which it has at any other period of life. This period is that of a real adipoſe cachexy. At the commencement of old age it melts, and ſuffers the ſkin which till then it had ſupported in a ſtate of tenſion, to collapſe as it were into a faded and wrinkled condition. The ſmall quantity of fat which remains in old men is hard, conſiſtent, of a deep yellow colour, ſometimes approaching to a brown. The ſame adipoſe phaſes take place in animals as in man: they however vary with them according to their nature, the ſtate of their blood, and the mode of their reſpiration.

25. The fat of the mammalia in general does not differ much from that of the human ſpecies. It has been obſerved that in the frugivorous and herbivorous animals it is more firm and more ſolid than in the carnivorous. It is to the firſt that the lard and tallow particularly belong. Spermaceti is a kind of fat which is extracted from the head and the ſpinal canal of the cacholot, and which is characterized by a dry and friable adipocerous conſiſtence, by a cryſtalline, lamellated and brilliant form, by its fuſibility inferior to that of ordinary fat, and by its ſolubility in alcohol. Of this I ſhall ſpeak more hereafter in detail, I here conſider it in general, becauſe this fatty ſubſtance is found in many other animal matters beſides the head of that ſpecies of whale.

The fat of birds is fine, mild, unctuous, and very fuſible. In fiſhes it is almoſt fluid or oily: it depoſits adipocire.

It exiſts in inſects, worms, and the teſtacea; in theſe it eſpecially accompanies the viſcera of the abdomen, where it is placed in ſmall lumps: it is alſo found, though more rarely, under their ſkin.

26. Diſeaſes have an influence upon the fat; it is itſelf ſometimes the cauſe of maladies. Its abundance conſtitutes a morbific affection; it has been known to augment the average weight of a man, which amounts to 80 kilogrammes, to 300. It ſometimes preſſes the heart, and retards and even ſtops its motion; it obtunds the nervous ſenſibility; it diſorganizes the muſcles; ſometimes their fibres are found converted into fat; it melts in moſt diſeaſes, and ſeems to ſerve as nouriſhment during the torpid ſtate of men and animals: thus the dormouſe, the marmot, &c. go into their holes very fat, and come out very meagre after the hibernation. After diſeaſes, eſpecially of the febrile kind, man is extremely meagre; much time is not required for the fat to be formed again. Some ſmall birds become extremely fat during a ſingle night when there is much fog. It aſſumes a yellow or green colour from the admixture of bile, which appears to have much relation with fat. It is ſometimes ſeen to flow off with the excrements in diſeaſes. When the external part of the body of animals

is made to grow lean by extreme heat, it is obſerved that their liver increaſes conſiderably in ſize. We ſhall ſoon ſee that this viſcus is in fact of an adipoſe nature.

27. Fat fulfils a great number of uſes in the life of animals; it maintains the heat of the parts by preventing the caloric, of which it is a bad conductor, to be diſengaged outwardly; it is known that fat perſons are leſs ſenſible to cold than lean ones. Galen mentions a perſon who always felt cold in the abdomen after having loſt a part of the epiploon by a diſeaſe. Macquer thought that it ſerves to abſorb the ſuper-abundant acids of the body of animals; but he founded this idea upon the concrete ſtate of the fat, which he believed to be owing to a combination of acid, and it is now known to be an error. This ſubſtance appears rather to abſorb the ſuper-abundance of hidrogen, and to be formed when the oxigenation is too little conſiderable. By its unctuous quality, fat facilitates the ſliding of the parts upon one another; it prevents the fibres from being glued together. It determines the rounded, graceful, and ſoft forms of ſeveral parts: it diſtends and ſupports the ſkin, at the ſame time imparting whiteneſs to it; it fills up vacuities and intervals between many fibres, textures, or organs. It renders the bones flexible and pliant; it paſſes from one part into another with much facility; it is abſorbed by the lymph, which renders it ſoluble; it in part nouriſhes animals,

who thus ſupport themſelves upon their own ſubſtance at their own expenſe.

28. Fat is employed for a great number of economical uſes. It not only ſerves as ſeaſoning to a great number of aliments, to which it communicates a mild unctuous quality; but it alſo is itſelf an aliment, and has very decided advantages in caſes of a too high oxigenation of the ſyſtem. It may therefore be adminiſtered in medicine, not only as has hitherto been done, as a lubrefacient, emollient, relaxant, and lenitive remedy, but alſo as a diſoxigenating medicine, or one which abſorbs that ſuper-abundance of oxigen, which manifeſtly, exiſts in inflammatory diſeaſes.

The numerous uſes are ſufficiently known to which it is applied in currying leather, in facilitating the motion of machines, in plaſters, in ſome mortars, &c. Every fat has, as is well known, its particular utilities.

ARTICLE V.

Of the Tranſpiration, of Sweat, and of the Humour of the internal Cavities.

1. THE inſenſible tranſpiration (a word which is ſometimes taken for the matter which iſſues in the form of vapour from the ſurface of the ſkin, and ſometimes for the function itſelf

by which this exhalation is effected) is one of the evacuations with which phyſicians have been the moſt occupied, and of which phyſiologiſts have not perhaps availed themſelves ſo much as the former have done for the theory and practice of their art. There is no phenomenon in animal life which has given riſe to more reſearches and explanations, or which has excited ſo much intereſt amongſt philoſophers. It was known by Hippocrates, Theophraſtus Eraſiſtratus, and Aſclepiades, who called it *pneuma,* becauſe they knew that it had the form, of air. Galen has made it one of the baſes of the pathological etiology. Sanctorius acquired, at the commencement of the ſeventeenth century, an immortal reputation by publiſhing the reſult of his long experiments upon tranſpiration, and the expoſition of its influence upon health and diſeaſes. His Medicina Statica, publiſhed in 1614, does not however contain the detail or the deſcription of his experiments, but only aphoriſms of which we do not always ſee the relation with the experiments themſelves, as theſe remain unknown; but at that period natural philoſophy did not exiſt; and too little attention was then paid to experiments for it to be thought neceſſary to preſent their detail, and an account of the manner in which they were conducted to the readers.

2. Towards the end of the ſame century, in 1668, Dodart, a phyſician, and member of the

Academy of Sciences of Paris, which had juſt been eſtabliſhed in 1668, communicated to it his reſearches upon tranſpiration: he contented himſelf, like Sanctorius, with giving reſults, and comparing them with thoſe of Sanctorius, in order to determine the differences preſented in this reſpect by the climate of Paris, ſituated at forty-nine degrees of latitude, compared with that of Venice, at forty-nine degrees, where Sanctorius had made his. J. Reil repeated ſimilar experiments during ten years at Northampton, ſituated at fifty degrees, and he was the firſt who publiſhed the detailed journal of them. Bryan Robinſon did the ſame in Ireland; G. Rye at Cork, and Linings in South Carolina, at thirty-three degrees of latitude. When we compare thoſe labours of more than a hundred years, which have not been continued during nearly ſixty years paſt, though this kind of reſearch promiſes, eſpecially for the laſt thirty years, many more important reſults than could have been formerly obtained, on account of the more advanced ſtate of the ſcience, we find unfortunately, together with ſome general truths, much uncertainty, contradiction, and error. Haller ſhows, in his great work of Phyſiology, that the authors of theſe experiments have not taken all the poſſible precautions, that they have neglected both the ſaliva and the pulmonary abſorption. He reproaches Sanctorius himſelf, who however has acquired ſo much fame, and who will always deſerve it in the memory of mankind, for having firſt made experiments, for having firſt conceived the idea of meaſuring the quantity of the tranſpiration by weight, and of placing the medical theory upon a ſure foundation; he reproaches him, I ſay, for having allowed too much to the tranſpiration, and for having forced the reſults in order to adapt them to the Galenic theory of which he was a follower.

3. In modern times I find only Lavoiſier and Seguin, who, having aſſociated together in order to examine the phenomena of tranſpiration, contrived to meaſure in particular and ſeparate from each other, by means both ingenious and exact, that which takes place in the lungs, and that which is effected by the ſkin, and to compare their relative quantity. We owe to them ſome important reſults; but only in a general way. Their reſearches, of ſome hours or ſome days only, do not preſent the long ſeries of thoſe of Sanctorius, of Dodard, of Kiel, of G. Rye, or of Robinſon, though they are far ſuperior to them in accuracy and preciſion. The French philoſophers have deſcribed with much care the means and the inſtruments which they have employed for making their experiments; and hence we may judge of the difference between them and thoſe of the phyſiologiſts who had preceded them in this career. Moſt frequently Citizen Seguin himſelf was the ſubject of theſe experiments. The balance which he employed, the beam

of which was four feet and a half in length, was ſo accurate, that when charged with 125 pounds or 62½ kilogrammes on each ſide, it was turned by a weight of two grammes, or half a drachm (gros). He placed and incloſed his whole body in a ſack of varniſhed ſilk, which having been blown up with air, had loſt nothing during fifteen days. This ſack was tied cloſe above his head: it had an aperture which was accurately glued round his mouth with a mixture of turpentine and pitch. The mouth being thus open, and communicating with the atmoſphere, the pulmonary tranſpiration paſſed into the air, and that of the reſt of the ſkin collected in the ſack, which let nothing eſcape. By weighing himſelf twice at certain intervals of three or four hours, he found the weight of the pulmonary perſpiration in the diminution which the balance gave him; by afterwards weighing himſelf in the ſack likewiſe at certain intervals, and twice in ſucceſſion, he had the weight of the cutaneous tranſpiration by ſubtracting from the total loſs that which he had found by the pulmonary tranſpiration, and always comparing the aliments and excrements with the loſs in inviſible effluvia. Hitherto in theſe experiments means were not ſought for aſcertaining the nature of the tranſpired fluid, and only the determination of its quantity was had in view. I ſhall ſhow elſewhere by what ingenious machines the ſame modern philoſophers, Lavoiſier and Seguin, have ſucceeded in carefully analyzing the phenomena of reſpiration.

4. Though the reſults obtained by theſe different experiments have pretty conſiderable differences from one another, without preſenting them in all their details, as Haller has done in his great work, it is neceſſary at leaſt to indicate the general reſults. In the northern countries, and according to the experiments of G. Rye, during the three winter months, there paſs out of the body 4797 ounces of perſpiration, and 3937 of urine; during the three ſpring months, 5405 ounces of perſpiration, and 3558 of urine; in the three ſummer months, 5719 ounces of perſpiration, and 3352 of urine; finally, in the three autumnal months, 4471 of perſpiration, and 3369 of urine. In a day of the winter there are, according to the ſame experiments, 53 ounces of perſpiration, and 42 of urine; in a day of the ſpring, 60 ounces of perſpiration, and 40 of urine; in a day of the ſummer, 63 ounces of perſpiration, and 37 of urine; finally, in a day of the autumn, 50 ounces of perſpiration, and 37 of urine.

According to the reſults of Keil, there are 31 ounces of perſpiration, and 38 of urine, ſo that the latter exceeds the former.

Dodart had found that the proportion of the tranſpiration to that of the ſolid excrements, was as 7 to 1, and to all the ſenſible excrements in general as 15 to 12. The medium quantity of perſpiration in France was, according to him, an ounce an hour.

Robinſon eſtimated, according to his experiments, that in youth the perſpiration was to the urine as 1340 to 1000, and in old age as 967 to 1000.

Hartman obtained, in analogous experiments, the following reſult: from 80 parts (ounces) of aliments eſcape by perſpiration 35, by urine 28, and by the ſolid excrements ſeven. According to Gorter, the proportion of theſe relations is ſuch, that of 93 parts of aliment 49 paſs by the ſkin, 36 by the urine, and eight in the ſolid excrements. We ſee, therefore, that there are differences between the reſults of all theſe experiments made in cold countries.

5. The reſearches upon the perſpiration in warm climates preſent almoſt an equal number of uncertainties and differences, though the experiments being leſs numerous afford reſults more eaſy to be brought to agree with each other. We are indebted for them chiefly to Sanctorius. He made them during nearly thirty years at Venice, where the air is hot and moiſt. His general concluſion is that from eight pounds of food taken in twenty four hours, five are diſſipated by tranſpiration, and only three paſs off by urine and the excrements. In this it agrees with thoſe of the preceding authors which belong to the hot ſeaſon. In the exceſs

of the perſpiration over the ſenſible excrements. Arbuthnot has confirmed them in the ſummer in England. Linings, who repeated them in South Carolina, likewiſe found that in ſummer the quantity of the perſpiration exceeded that of the ſenſible excrements. Many moderns have queſtioned the reſults of Sanctorius, and have thought that they were manifeſtly carried too high. Haller concludes, from all the experiments made by the different philoſophers who have been quoted, compared with each other, that it is doubtful whether the perſpiration exceed in quantity that of the urine, if we take the average of all the reſults which they have obtained ; and that they all differ eſpecially from thoſe of Sanctorius by much ſmaller quantities.

6. We ſhall ſee by the reſults which we owe to the laſt experiments of Lavoiſier and Seguin, that they have frequently obſerved phenomena analogous to thoſe already indicated : but that they have alſo ſeen ſome that are new and different. The following are the inferences which they have obtained from their reſearches.

a. Every four and twenty hours the body returns to the ſame weight when the ſubject is in health and when he is not in the progreſs of growing fat.

b. Bad digeſtion retards perſpiration. He increaſes in weight during four days ; and on the fifth he generally returns to the primitive weight. Sometimes the equilibrium is re-eſtabliſhed rather by the augmentation of the excrements than by that of the perſpiration.

c. Drink only, and not the ſolid aliments, increaſes perſpiration.

d. The perſpiration is at it its *minimium* during meals and immediately after them: it attains its *maximium* during digeſtion.

e. The maximum is 32 grains a minute, or 25 hectogrammes in twenty four hours; the minimum is 11 grains a minute.

f. The perſpiration is in the compound ratio of the force of the exhaling veſſels and of the diſſolvent quality of the air.

g. The pulmonary perſpiration is more conſiderable, relatively to the ſurface of the lungs than the cutaneous perſpiration is in proportion to the ſurface of the ſkin. It is ſtill more conſiderable in the winter, on account of the neceſſity of keeping up the temperature of the body at thirty two centigrade degrees.

7. Though the proportion of the perſpiration is one of the moſt important objects to Phyſiology and medicine, there is a ſecond which is alſo of importance and belongs more to the province of Chemiſtry; namely, the knowledge of the matter which iſſues in this manner out of the pores of the ſkin. But few reſearches have hitherto been made upon this ſubject. and it is one of thoſe with which Phyſiologiſts have leaſt occupied themſelves.

Haller conſidered as the materials of this evacuation the water reduced into vapour which is frequently viſible. Tachenius was the firſt who collected it, by incloſing his arm in an oiled cloth; but he has not examined its nature. Bonnet, Bellini, Winſlow convinced themſelves of its emiſſion. Liſter by keeping his arm plunged in a cold glaſs; obtained a ſaline water from it. Kaw and Gorter have eſpecially inſiſted upon the water which the contact of the ſkin depoſits upon the ſurface of Glaſs, and have remarked that the air ſpeedily diſſolves it. To this firſt ſubſtance, this vaporized water accompanied with ſome ſalts, Haller added the electric matter, the ejection of which he thought to prove by the ſparks, the ſmell, the decrepitation, which have ſo often been obſerved in the cloaths at the moment when they have been taken from the body, and in the frictions applied to the hairs of cats; but it is evident that he has confounded the electric effects produced by friction with a pretended electric emanation which nothing proves to take place. The ſame phyſiologiſt alſo ranked amongſt the elements of the perſpiration:

a. Fetid volatile parts which he ſaid were the moſt denſe and to which he attributed the traces followed by the venatory animals.

b. Particles of drink and aliment, proved by the ſmell. On this occaſion he refers to the reſult obtained by G. Rye; namely, that from two pounds and four ounces of aliment, only four ounces paſſed off by the excrements and two pounds by the ſkin.

8. The new chemical data and a more profound examination of the perſpiration have led to the diſcovery of ſomething more in it than what had been admitted by the illuſtrious Haller. It is not true that there paſs off through the ſkin, as ſome moderns have thought, elaſtic fluids and eſpecially carbonic acid gas; but there is reaſon to believe that at the ſurface the neareſt to the ſkin, namely in its immediate cavities there is diſengaged and burned a portion of carbon; perhaps even a certain quantity of carbonated hidrogen exhales through its pores and experiences a ſlow combuſtion. This we ſhould eſpecially be led to believe by obſerving that the ſkin, expoſed immediately to the air, and not covered with clothes, aſſumes a fawn or brown colour which ſeems to announce the fixation of a greater quantity of carbon; perhaps even it is this phenomenon in a highly exalted ſtate with the negroes, which colours their mucous texture and the interior ſurface of their epidermis. It is known that they are not born with this colour, but that it is formed, or at leaſt grows conſiderably darker by the progreſs of life.

There is no doubt that water ready formed paſſes off through the ſkin and that it conſtitutes the greater part of the perſpiratory vapour. Citizen Berthollet has ſometimes found an acid in it, and he has even diſcovered in it the phoſphoric acid. If this acid were diſcharged regularly and conſtantly, it muſt neceſſarily accumulate upon the ſkin, for it is not volatile even with the aid of the vaporized water.

9. The matter of the ſweat has been thought to be analogous to that of perſpiration; and it has been believed that it differed from it only in not paſſing off in the form of vapour, and diſſolving in the air much more ſlowly; and though ſome phyſiologiſts have imagined the ſweat to be a different ſubſtance and even to have its particular organs, we muſt however admit an identity of nature between theſe two excrementitious humours. It is known that the ſweat is a ſaline water, a little viſcous, in which Lewenhoeck had deſcribed globules, and which has been little ſubjected to analyſis; but which Raymond, Bohnius, Liſter, and Tachenius have thought to be ſimilar to urine. According to ſome experiments, Petit has found it to be alkaline and turning the colour of violets green. Frequently it has a ſour ſmell and turns blue paper red. It has been known to ſtain the linen yellow, green, blue, or black; it is known that it has very various odours, but in general acrid and diſagreeable; that it ſometimes partakes of that of the aliments; that it is highly odorous and even fetid in animals in heat; that it is ſometimes accompanied with fat, with blood, or with bile; that it thickens upon the ſkin, and leaves upon it a kind of yellowiſh or brown

reſiduum; that it ſometimes depoſits ſandy concretions, or ſaline cryſtals which Haller aſſerts he has ſeen upon the ſkin of glaſs-makers; that it forms upon the ſkin of the horſe a concrete white or yellowiſh ſtratum, which Citizen Vauquelin and myſelf have aſcertained to be real phoſphate of lime, detached and ſeparated in ſmall ſcales by the action of the curry-comb; that its quantity varies extremely from ſome decigrammes only to a kilogramme and a half. Cardan reckoned the quantity of ſweat diſcharged by a patient under a courſe of mercury at four kilogrammes and a quarter. Continued ſweat is always a ſevere diſeaſe, on account of the loſs of ſubſtance and the debility which it occaſions. It is no longer believed with Lewenhoeck that fifteen ſmall drops of inſenſible perſpiration form one drop of ſweat, but it is believed that the ſweat is the product of the accumulation of the molecules of perſpiration which the air cannot carry off.

10. All anatomiſts now agree with reſpect to the organs which exhale the perſpiration. They think that it iſſues from the extremities of exceſſively numerous minute arteries which open under the ſkin, and which, on account of their extreme tenuity, ſuffer only the lighteſt part of the liquid which they contain to paſs. They are convinced that it is not from the lymphatic veſſels that it proceeds, but that the function of theſe is oppoſite to that of exhalation. It will however be obſerved that ſince Haller and the

phyſiologiſts who have followed him, in admitting that the perſpiration proceeds from the cutaneous arterial extremities, ſuppoſe that theſe ſmall arteries convey only a white and aqueous liquid; they actually admit a ſecond order of veſſels which terminate the arteries, and which are the real white veſſels of Boerhaave. For the reſt, injections violently paſſed through the arterial cavities, ſometimes, though with difficulty, paſs out through the cutaneous pores, or diffuſe themſelves under the epidermis; ſo that if theſe injected liquids were ſufficiently attenuated, ſufficiently hot, and continually puſhed forward, they would actually give riſe to an artificial perſpiration.

11. A kind of conſideration which has hitherto been almoſt foreign to phyſiologiſts, which had almoſt entirely eſcaped the ſagacity of Sanctorius, of which the illuſtrious Haller himſelf abſolutely ſays nothing in the long details which he gives concerning the perſpiration, which Kauw, in his work upon perſpiration has alſo paſſed over in ſilence, and which modern chemiſtry alone has almoſt totally drawn into notice, is the influence of the air in the exerciſe of this function. It is ſuch that perſpiration cannot take place without its contact, that it contributes to it in an immediate manner, that it determines its proportion, that it augments it, diminiſhes it, raiſes it to its maximum or depreſſes it to its minimum, that we ought to affirm at preſent, as Lavoiſier and Seguin

firſt ſhowed with perſpicuity, that the perſpiration is in the compound ratio of the velocity communicated to the tranſpiring fluid by the veſſels which convey it to the ſkin, and of the power with which the air diſſolves it. We recognize the exiſtence of this ſolvent property of the air, when we conſider with attention what paſſes at the extremity of the fingers; we there ſee, eſpecially in the ſummer, ſmall liquid drops iſſuing out of the pores ſituated at the bottom of the elliptrical groves with which this region is ſtreaked, which are ſoon diſſipated in the air and continually renewed, in order to be afterwards taken up and evaporated by the air. The ſteam riſing out of the lungs, from the head, from the hands when taken out of bed, and which we ſee elevate itſelf in torrents into the atmoſphere, is only the tranſition of the liquid perſpiration to the ſtate of claſtic fluid which the air ſoon gives it; it is neceſſary therefore, in order that perſpiration ſhall take place, that the air ſhould diſſolve it in proportion as it iſſues out of the cutaneous pores. This ſolution is accompanied with a refrigeration which every one experiences, and which moderates the heat to which the body is raiſed under certain circumſtances.

12. It muſt be very evident, according to this exact notion, that ſuppoſing the conditions of the perſpiration to be the ſame with reſpect to the body which perſpires, to the temperature, to the motion of the reſpiration and of the

blood, and to the quantity of perſpirable matter, if the ſolvent quality of the air ſhould happen to vary, variations muſt alſo enſue in the exerciſe of this function. This datum may not only greatly contribute to elucidate the obſervations of Sanctorius, of Keil, of Gorter, of G. Rye, &c. but it muſt alſo introduce important modifications into the notions that have been promulgated reſpecting perſpiration: it may even change a part of the notions that have till the preſent time been conſidered as exact, and in this point of view change the aſpect of the healing art. There is wanting in this reſpect a ſeries of experiments which it is very neceſſary to attempt at the preſent moment; but notwithſtanding this chaſm there are ſome certain principles which are capable of throwing a new light upon the cauſe and nature of diſeaſes, which eſpecially may deſtroy erroneous opinions which have long prevailed. It is evident, after what has been ſaid, that if the air be little charged with moiſture, if it be of a temperature raiſed a little above 15 degrees, for example, if it be frequently renewed at the ſurface of the ſkin by its agitation or its currents, it then combines all the conditions requiſite to its diſſolvent quality; it muſt then take up much water from the ſkin, and the perſpiration muſt be the moſt accelerated and the moſt abundant poſſible. If, on the contrary, the air be hot and moiſt, if it be charged with water to ſuch a degree as to precipitate a part of it, it can take up little or nothing from the ſkin and the perſpiration muſt be conſiderably diminiſhed or completely ſtopped. This phenomenon frequently takes place in the ſummer, and if it ſucceeds the preceding, the ſkin, which no longer loſes any thing, becomes covered with ſweat, grows ſoft, and the body becomes more heavy.

13. It follows from theſe firſt principles, that when the air in winter, though very low in its temperature, at 10 or 15 deg.—0, is extremely dry, denſe, and agitated; in proportion as it touches the ſkin, it takes from it much caloric, becomes heated at its ſurface, and becomes a ſolvent of water doubly active, both on account of its dry ſtate and of its elevation of temperature; it therefore carries away the more perſpiration the more frequently it is renovated, the more ſwiftly it is moved. Accordingly, in a cold, dry and windy winter, this very highly diſſolvent ſtate of the air, which is perceptible even by the manner in which it evaporates and dries the earth, pavements, and ſurfaces of buildings, vaporizes and carries away ſo much water from the ſkin that it dries, cracks, and riſes in ſcales; that the body ſuffers a great waſte of ſubſtance; that on account of the neceſſity of reparation, the digeſtive powers increaſe rapidly in robuſt and healthy ſubjects; that the urine becomes thick and turbid; that the humours thicken and become viſcous, and diſpoſed to inflammation. Such is the ſource of catarrhs, defluxions from the lungs, pleuriſies,

inflammatory fevers, proceeding, as we ſee, from the ſluggiſhneſs, thickneſs, and viſcidity which the liquids have contracted, much more than from a ſuppreſſed perſpiration, as has hitherto been ſo generally believed. From what has been ſaid, we may conclude, that in dry and windy cold weather, the perſpiration is the moſt abundant poſſible; that it ſenſibly exceeds that of the ſummer; and amongſt the experiments that have been quoted, eſpecially thoſe of G. Rye, Robinſon, and Gorter, we find, when we read them with attention, reſults favourable to the opinion which I have advanced.

14. We alſo ſee, according to this theory, which is founded upon well demonſtrated facts, and upon notions more preciſe than thoſe which have hitherto been followed, that the contact of cold water covering the ſkin muſt prevent the perſpiration; that the bath cannot augment or maintain it, or even let any part of it ſubſiſt, except in ſo far as by its more or leſs elevated temperature, it augments the pulſations of the heart, and the force which impels the liquids toward the ſurface of the body; that frequently it would be either entirely checked or very much diminiſhed in ſubjects immerſed in a lukewarm or cold bath, or if the portion of their body which is out of the water, if the pulmonary ſurface did not perſpire in an increaſing proportion; that their body would be very much augmented in weight, if a more

abundant excretion of urine did not replace the water retained at the ſurface of the wet ſkin. We thus ſee why a covering of waxed ſilk applied over any part of the body becomes filled with water, and ſoon ſtops the perſpiration. We alſo underſtand the utility of ventilation, which diminiſhes the heat and the ſweat by renewing the ſolvent air around the body. We conceive that perſons wrapped up in blankets muſt have a moiſt ſkin, without on that account really tranſpiring, becauſe they want the contact of the air, the indiſpenſable agent of tranſpiration; and when phyſicians adviſe confinement to a warm bed, and the application of blankets, in order to make patients ſweat, the good which they thereby procure them is almoſt always the retention of the perſpiratory water which the air would have carried away from them, much rather than the diſcharge of a larger quantity of this liquid. There is even reaſon to think that this mode of treatment matures catarrhs only by actually retaining the water in the body, and thus favouring the dilution of the thickened portions of liquids, and their more eaſy ſeparation from the ſides of the canals to which they were in a manner attached by their glutinous and tenacious thickening. It is ſufficient to have announced the baſes of theſe new truths, in order to ſhow what productive applications they are ſuſceptible for the knowledge of the cauſes of ſeveral diſeaſes, and the inveſtigation of the means of combating them, ſupported by direct experiments. They will become one of the baſes of the new monument which chemiſtry muſt ſoon raiſe for the art of healing.

15. Phyſicians have long obſerved a remarkable analogy and ſtriking relation between the urine and the perſpiration; they have obſerved that the one of theſe evacuations frequently ſupplies the place of the other, and that they are conſtantly in an equilibrium which is always maintained when the body is healthy and vigorous. In fact, when the perſpiration is diminiſhed or ſuppreſſed, eſpecially by the non-diſſolvent or little diſſolving ſtate of the air, the urine is diſcharged in greater abundance, and it ſeems as if there were a direct paſſage open between the cutaneous pores and the tubes of the kidneys. Some anatomiſts even admit, on account of the rapidity and magnitude of this effect, another paſſage than that of the kidneys for conducting the humour of the perſpiration into the bladder. Some moderns think that this function is performed by the ſyſtem of abſorbent or lymphatic veſſels, without however having yet proved their immediate communication between the ſkin and the bladder. But this is not the point of view under which I ought here to conſider the analyſis of theſe two evacuations; the nature alone of the liquids which form them muſt eſpecially form the object of my attention. I have already remarked, that ſome phyſiologiſts have found a

real identity between the matter of perſpiration and that of the urine, and that the ſole difference which they have announced between them conſiſts in the greater quantity of water which the firſt conveys, and the leſs degree of ſaline acrimony which characterizes it. I muſt here add, that ſome of our recent experiments confirm this idea, and that Citizen Vauquelin and myſelf, after having diſcovered a particular urinary matter, which I ſhall deſcribe elſewhere by the name of *urée,* exiſting conſtantly in all the urines of the different animals which we we have been hitherto able to examine, have found it again in the reſiduum of the tranſpiration of the horſe after the evaporation of this humour. I ſhall alſo obſerve, that Citizen Berthollet has indicated a tranſpiration which is acid like the urine, and conſequently that chemiſtry has the means of determining this analogy which has been announced ſo long ago by the experience of phyſicians.

16. In deſcribing the different uſes of the tranſpiration, phyſiologiſts enumerate the ſoftening of the ſkin and of the epidermis, as alſo an excrementitious evacuation which carries out of the body matters, the abundance and acrimony of which might be equally prejudicial; they ſupport the latter opinion by the origin of numerous diſeaſes, which are generally attributed to diminiſhed, retained, repelled, or ſuppreſſed tranſpiration. Galen, after Aſclepiades, has ſtrongly inſiſted upon this uſe of

tranſpiration, which we find was adopted in the ancient Grecian ſchools of medicine. Sanctorius has carried it ſo far as to pretend that as long as this function is in its regular ſtate, no diſeaſe is to be apprehended. Many phyſicians have believed that the diminution of the perſpiration in old perſons was the real cauſe of the gout, and the rheumatic affections ſo common at that age.

Some philoſophers, however, have called in queſtion this uſe of the tranſpiration; they have aſſerted that this evacuation might be diminiſhed, or even ſuppreſſed without injury to the individual: they have quoted the example of nations who cover their ſkins with greaſe and oil, and who, inſtead of ſuffering from this covering which intercepts the perſpiration, find in it the means of augmenting their ſtrength. Bacon even ſuggeſted that this artificial occluſion of the pores of the ſkin might be a means of preſerving life, and retarding the effects of old age. It is true that where they quote the pretended ſuppreſſion of the perſpiration during the winter, without the production of diſeaſe, the advocates for this opinion have committed a great error, as it appears, on the contrary, that in the caſe mentioned (No. 13), this evacuation is very conſiderable. There is reaſon to believe, that in the inſtances quoted by theſe authors, other excretions of the urine, of the pulmonary tranſpiration, and that of the internal cavities, increaſe in proportion as that of the ſkin diminiſhes, and ſupply its place.

17. Modern philoſophers have added ſeveral new notions concerning the uſes of the perſpiration, by repreſenting it as an abundant evaporation of water at the ſurface of the body: they have ſeen in it a means of abſorbing the too great quantity of caloric that diſengages itſelf from it, of regulating its temperature, and maintaining it at a conſtant term; of thus evacuating the exceſs of caloric which develops itſelf, either in the lungs by reſpiration, or in the circulation itſelf by the fixation of the oxigen which appears to be continued in it, and to follow its intimate combination. They therefore conſider this function in uninterrupted relation with the reſpiration, and as the regulator of the animal calefaction: they thus explain how, when this calefaction is augmented by any cauſe, the perſpiration, having ſuddenly become abundant, tends to moderate it, and to reſtore it to its original equilibrium. Perhaps the phenomena of the tranſpiratory function may be carried ſtill farther, and conſidered as the diſcharge of the water which is formed in the courſe of the arteries by a flow but continual combuſtion of the hidrogen of the blood by the oxigen abſorbed in reſpiration, as well as that which takes place in the pulmonary veſicles. This water carries away with it a part of the animal ſolids and fluids in the ſtate of vapour; and by thus evacuating the

part of the organs that is too much anamalized and worn, it contributes as it were, to ſolicit their renovation. For the reſt, theſe ideas deſerve to be ſtudied and ſupported by experiments made with more accuracy, and under the guidance of more enlarged views than thoſe which have given celebrity to the names of Sanctorius, Dodart, Keil, B. Robinſon, G. Rye, Linings, Gorter, &c.

18. There continually exudes in the internal cavities of the body, in all the hollow viſcera, in the dura mater, in the ventricles of the brain, the pleura, the mediaſtinum, the pericardium, the peritoneum, &c. a humour which lubricates their ſurfaces, which the phyſiologiſts have repreſented as a humid vapour, an internal *halitus*, a ſort of internal tranſpiration, the exiſtence of which has been proved by numerous obſervations. Haller has made expreſs mention of it in his great work on phyſiology. Borden conſidered it as a ſtream of vapour which ran through not only the internal membranous cavities, but alſo all the cells of the muſcular texture, and he repreſented the body to himſelf as conſiſting of cellular balls, all open and all communicating the one with the other, only contract from ſpace to ſpace. But theſe ideas, which were ingenious in their time, muſt be modified by the knowledge of the lymphatic or abſorbent ſyſtem, and the humour of which I here ſpeak muſt not be confounded with that which fills the abſorbent veſſels, and

which always follows in them a determined courſe.

19. The humour of the interior cavities exudes from the extremities of the arteries, as is proved by injections, and nevertheleſs it differs from that which is exhaled by the ſkin; it is much leſs aqueous and charged with more fixed matters than the latter. We ſhall well comprehend the cauſe of this difference, when we conſider that the perſpiration is formed only of the ſubſtance which is capable of being volatilized and diſſolved in the air, whereas the humour of the interior cavities is neither a vapour nor a gaſeous ſolution, but a liquid which runs by the effect of the circulation and of the motion of the blood. In proportion as it thus exudes from the internal ſurface of the membranes which it moiſtens, it is re-abſorbed by the orifices of the abſorbent veſſels, ſo that it never accumulates to ſuch a degree as to diſtend theſe membranes; it always forms in them only a light mucous covering which ſeparates from it and lubricates their ſurfaces, whilſt the animal is in health and vigour.

20. We may diſtinguiſh the viſcous, mucilaginous, gluey ſtate of this liquid, by introducing the finger into theſe internal cavities and upon the membranous ſurfaces, either of living or of dead animals. We perceive, by the mere ſenſe of touch, that this humour is really an albuminous and gelatinous ſolution analogous to ſerum. It is only by theſe ſimple experiments that we can

eſtimate its nature; for it is not ſufficiently abundant in the natural and healthy ſtate to be capable of being collected and examined by chemical proceſſes. Sometimes however it happens, that this lubricating ſerum accumulates in the viſceral cavities; this takes place whenever the function of the ſyſtem of abſorbent veſſels is languid, or when its energy is not ſufficient for taking up again by ſuction the quantity of liquid which iſſues from the arterial extremities. Dropſy then exiſts, and the liquid which conſtitutes it, when extracted by the puncture, becomes ſufficiently abundant to be ſubjected to analyſis; ſo that we are then able to aſcertain the nature of the internal humour.

21. Rouelle the younger was the firſt who examined what is called the *hydropic water*. That of the aſcites, which he employed, afforded him all the characters of the ſerum of the blood. I have made the analyſis of this liquid, extracted in different ſpecies of dropſies, of the breaſt, of the pericardium, of the ovarium, in the aſcites, and I have conſtantly found in it the ſame characters. This liquid is generally viſcous, gluey, yellowiſh, of a ſweetiſh and ſomewhat ſaline taſte, charged with flakes more or leſs abundant and voluminous, of a yellowiſh-grey colour. It is coagulated by fire, by the acids, by alcohol; it is precipitated by the calcareous and metallic ſalts; it turns the ſyrup of violets green: the flakes which ſwim in it are coagulated albumen;

though generally freſh and unaltered in the hydropic cavities, it quickly putrefies by the contact of the air. When it is heated, it affords coagulated, porous, light maſſes, of a ſulphur-yellow colour, and tremulous conſiſtence; there remains a ſlightly yellowiſh liquid which does not coagulate. When diluted with water and heated, it forms a milky not coagulable liquid; it affords at its ſurface, by the progreſs of the action of the fire, a thick yellow pellicle like milk. Boiling water attacks and diſſolves the matter that has been coagulated by the fire, ſo that it then preſents the appearance of a gelatinous ſubſtance. However, we can obtain no real jelly from this liquor, though ſtrongly evaporated and afterwards cooled; pellicles are ſeparated from its ſurface from the beginning to the end and during the whole courſe of this evaporation. The albuminous matter therefore does not exiſt in it in the real ſtate of gelatin.

22. Sulphur and phoſphates are alſo exhibited by different proceſſes in the hydropic liquor. The firſt is perceptible by the fetid ſmell which this liquor exhales when coagulated, by the colour which its vapour imparts to ſilver, by the ſulphuric acid which is formed in it by the oxigenated muriatic acid, and which is diſcovered by the aid of the muriate of barites. As to the phoſphates, lime-water, the ſolutions of barites and ſtrontian, poured into the hydropic water, produce in it precipitates,

tates, which are eaſily diſcovered to be phoſphates, on account of their inſolubility and the manner in which they comport themſelves under the action of fire. The nitric ſolution of mercury forms in it alſo a fleſh-coloured precipitate. The coat of the hydropic water, evaporated to dryneſs and burned in a crucible, affords ſome traces of calcareous phoſphates, but leſs abundant than almoſt all the coats of other animal matters. It is uſeleſs to add, that the coagulum afforded by this water when heated, affords in diſtillation the ſame products as thoſe of which I have ſpoken in the hiſtory of the ſerum.

23. We muſt not confound with the water of the internal ſurfaces of the membranes the ropy and mucous liquid which lines the ſides of the hollow viſcera, of the canals communicating with the external part of the body, opening into the air, and immerſing themſelves into the interior part of the animal cavities, ſuch as the oeſophagus, the trachea, the inteſtines, the urethra, the vagina, &c. The mucus deſtined to lubricate theſe parts and to prevent their dryneſs and rigidity, is of a different nature from the matter of the tranſpiration, though, like it, it iſſues from the ſurface of the delicate and thin portion of the epidermis which inveſts thoſe canals, and which is called epithelium. Inſtead of being evaporable like the tranſpiration, it contains a kind of gelatinous albumen, little ſuſceptible of deſiccation, rather

deliqueſcent, which the air thickens only with difficulty, and which preſerves the pliability, ſoftneſs, and mobility of the ſides of the canals where it is depoſited. It ſeems to be of a compoſition entirely oppoſite to that of the tranſpiratory humour, no leſs ſuſceptible of preſerving its viſcoſity, its ſoft and as it were unctuous conſiſtence, than the other is of becoming volatilized and diſſolved in the air. Accordingly, it performs an entirely different office, ſince it maintains the ſoftneſs and heat of the ſurfaces, whilſt the other tends to dry and cool them.

Article VI.

Of the Synovia.

1. THE Synovia is an unctuous humour, deſtined to lubricate the articular cavities, and to facilitate the motions of the heads of the bones upon each other. Clopthon-Havers was the firſt anatomiſt who deſcribed particular glands ſituated in the articulations as the ſource of this humour; but ſome modern phyſiologiſts now doubt whether ſuch be the true origin of the Synovia. The following are the arguments which Xavier Bichat principally adduces, in a very good diſſertation upon the

membrane, which includes this liquor, publiſhed in the ſecond volume of the Memoirs of the Medical Society of Emulation at Paris. All the articulations do not contain the pretended ſynovial glands deſcribed by Clopthon-Havers. The mucous capſules of the tendons which facilitate the ſliding of theſe parts by the preſence of the ſame humour which their cavity contains, have not generally glands of this nature. Thoſe bodies, which were taken for glands by Clopthon-Havers, are only cellular texture ſuſtaining blood-veſſels collected into reddiſh balls; they are unfolded into floating membranes; they do not tumefy nor harden as the real glands do, and their pretended glandular nature diſappears under the ſcalpel or by other anatomical proceſſes: beſides theſe granulated lumps or cellular balls are found in other places beſides the ſynovial membranes.

2. The ſame anatomiſt does not confine himſelf to combating the opinion of Clopthon-Havers concerning the ſynovial glands and the ſource of the Synovia: he has collected a great number of facts and arguments in order to prove that this humour has another origin and to diſcover whence it proceeds. For this purpoſe he deſcribes with much greater accuracy and preciſion than had been done before him, the membrane into which the Synovia exhales, where it remains contained for ſome time, and is abſorbed ſo as to be perpetually renovated. According to his reſearches, this

membrane, which he calls *ſynovial*, and which is incloſed in all the articulations, is a bag, or kind of ſac without orifice, folded together, of the nature of the ſerous membrane, analogous to the pleura, to the pericardium, thin, tranſparent, diſtinct from the articular capſule, and to the internal face of which it adheres, detaching itſelf from it below the heads of the bones, leaving a portion of thoſe bare, paſſing over the articular cartilages which it covers, adhering ſtrongly to them, folding back upon the interarticular ligaments and cartilages and the glanduliform balls; ſo that the heads of the bones, the articular capſules, and the interior ligaments of the articulations are on the outſide of this ſynovial membrane. We may extend and inflate it by blowing from the interior of the articulations at the points where the articular capſules are interrupted. It is this ſynovial membrane, contained, as we ſee, in the articulations, covering all the interior ſurfaces, filling their cavity, having a ſmooth, poliſhed, and ſhining ſurface, upon which the ſliding of the articulated bones takes place. Citizen Bichat thinks that it is formed by an intertexture of exhalant and abſorbent veſſels, the firſt conveying the ſynovia by exhalation, the ſecond taking it up proportionally.

3. Founded upon this ſtructure, this anatomiſt who has given an account of it, after having compared this membrane with thoſe which he calls *ſerous;* that is to ſay, thoſe

which occupy and inveſt the large cavities, cover the viſcera, and are ſacs without orifice, ſuch as the pleura, the pericardium, the peritoneum, the tunica vaginalis or of the teſticles, concludes from this analyſis that there conſtantly iſſues from the interior ſurface of this internal capſule of the articulations a gluey and viſcous liquid, as well as from thoſe of other ſerous membranes, and that this humour is what is here termed the *Synovia.* In order to confirm the identity of its nature with that of the lubricating humour of all the other cavities of the ſerous membranes, he follows its analogies under four general relations: 1. its nature is ſimilar; it is, like it, albuminous, ſince, like the latter, the Synovia, being of a viſcous conſiſtence, is coagulable by fire, by the acids, and by alcohol; which Clopthon-Havers had already remarked; 2, it performs the ſame functions as the humour of the internal cavities, ſince, like this, it ſerves to render its ſurfaces ſmooth, and to favour the motion of theſe internal ſurfaces; 3, the Synovia preſents an equally ſtriking analogy with this humour in the diſeaſes to which it is ſubject; in fact, we obſerve its thickening give riſe to adheſions between the ſurfaces of the ſynovial capſules, as between the pleura, the peritonæum, and the viſcera which are contained in them; we alſo find hydropic accumulations of the Synovia, as we do of the humour of the other membranes; 4, finally, the ſynovial humour is abſorbed by lymphatic veſſels, and renovated by the continually renewed exſudation in the interior of the ſynovial membranes or capſules, like the humour of the other internal cavities.

4. However, Citizen Bichat finds a difference between the apparatus of the ſynovial capſules, as well as the formation of the Synovia, and the ſtructure of the veſſels of the ordinary ſerous membranes. He obſerves that the abſorbent ſyſtem of the ſynovial membranes muſt differ from that of the other abſorbents ſituated in the other parts of the body, ſince in the leucophlegmatia the ſub-cutaneous abſorbents are every where obſtructed, whereas this obſtruction does not take place in the articulations. This obſervation, however, is not ſufficient for eſtabliſhing a difference between the two ſyſtems, and may be explained by the diverſity of the layers of the abſorbents; for it is known that the ſuperficial or ſub-cutaneous abſorbents form a ſyſtem, if not totally independant of the deep-ſeated lymphatics, at leaſt ſufficiently ſeparated from theſe not to participate always in the ſame affections with them. I am much more ſtruck with a difference of infinitely more importance between the Synovia and the humour of the internal cavities; namely, that of the quantity and of the phyſical properties which very eminently diſtinguiſh theſe two liquids from each other. The latter is never ſufficiently abundant to run out at the orifice of the membranes, nor thick and ſtringy,

as we find the Synovia: accordingly, when this thickens, it gives riſe to anchyloſes or ſolid adheſions of the joints, whereas the humour of the membranous cavities forms only mucous, tenacious and flaxey ligaments.

5. I have already obſerved that the Synovia is an unctuous liquid: its viſcoſity is ſuch, that it was formerly compared to an oil, and almoſt to thoſe greaſy matters which are employed for facilitating the motions of wheel-work. This ſingle character, which all anatomiſts have aſcribed to the Synovia, would be ſufficient to diſtinguiſh it from the humour of the interior cavities, though the expreſſion which has been employed for rendering it is altogether improper. It is in ſufficient quantity to be collected with eaſe at the orifice of the ſynovial capſules which contain it in the articulations of large animals; it is either tranſparent or ſlightly opaque, a little greeniſh, of a conſiſtence analogous to that of white of egg, of a ſweetiſh and ſomewhat ſaline taſte, of a faint animal ſmell, analogous to that of frog's ſpawn. Its ſpecific gravity is ſuperior to that of diſtilled water. Phyſiologiſts have hitherto given only a very imperfect and very general notion of this liquor. None of them have made a real chymical analyſis of it. Citizen Margueron, apothecary to the Maiſon des Invalides in Paris, read to the Academy of Sciences, in June, 1792, a chemical examination of the Synovia, and this is the only inquiry made with any attention that I know. In exhibiting

the reſults of his experiments, I ſhall ſubjoin ſome reflections concerning the neceſſity of repeating them and reviewing ſome facts which deſerve all the attention of the philoſopher.

6. Citizen Margueron eaſily procured the Synovia of the bullock from a butcher's ſhop where ſeveral were killed every day. This liquor aſſumes a gelatinous conſiſtence ſome time after having been extracted from the joints, both in the cold and in a mild heat, as well in cloſe as in open veſſels : it does not long retain this conſiſtence ; it even ſoon loſes its firſt natural viſcoſity, and depoſits a ſtringy matter ; it preſents ſome differences in its analyſis, according theſe different ſtates ; when it is filtrated as ſoon as it has been extracted from the joints, it nevertheleſs preſerves all its properties. A thin layer of ſynovia expoſed to a dry air in a flat veſſel, dries into a ſcaly net-work, in which two ſaline matters are obſerved ; the one in cubes, which is muriate of ſoda ; the other effloreſcence and eaſily diſtinguiſhable as carbonate of ſoda ; the freſh ſynovia alſo turns the ſyrup of violets green. In a moiſt air this liquor becomes altered and putrefied ; whilſt it loſes its viſcoſity, it becomes turbid, exhales a ſmell of putrid fiſh, aſſumes a red or brown colour, becomes covered with a pellicle, and leaves a ſoft and fetid reſiduum, from which lime and the alkalis diſengage a large quantity of ammonia. Diſtilled in the retort, the Synovia afforded Citizen Margueron a very alterable water charged with

ammonia; at laſt, an empyreumatic oil, carbonate of ammonia, and a coal which contained muriate of ſoda, and phoſphate of lime.

7. The Synovia eaſily mixes with cold water, in which it firſt occupies the bottom, but diſſolves in it by agitation. The author obſerves that it gives to water a very remarkable viſcous fluidity, as it is very ſenſible even when we take ſix parts of water to one of this humour. The mixture froths much by agitation: frequently in ebullition, it preſerves its viſcidity, becomes opaque, milky, and exhibits ſome pellicles at the ſides of the veſſel. The author was ſo ſtruck with the conſiſtence communicated to water by the ſynovia, that he aſſerted no animal liquor preſented any thing ſimilar; he thought he had found its cauſe by the action of the acetous acid. The addition of this acid to the mixture of ſynovia and water cauſed it to loſe its viſcoſity, rendered it clear and tranſparent, made it depoſit a maſs of white fibres eaſy to be ſeparated from the liquor, by tubes of glaſs, which carried them away in a ſingle piece. The liquor thus clarified being put to evaporate, afforded him albuminous pellicles and afterwards cryſtals of muriate of ſoda, and of acetite of ſoda in ſtriated priſms. It was undoubtedly from this experiment that Citizen Margueron ſuppoſed albumen to exiſt in the ſynovia in two ſtates, more denſe than in the other animal liquids, and conſequently capable of imparting a greater viſcidity

to water. I ſhall ſoon ſhow that there is reaſon to believe that this property may depend upon another cauſe which could not even have been ſuſpected in 1792, or at leaſt that it deſerves to be ſtudied under new relations, and with a new intereſt, as it may greatly elucidate both the functions of the ſynovia and the nature of its morbid affections.

8 Citizen Margueron treated the ſynovia with different acids. The concentrated ſulphuric acid, he ſays, produced a flaky precipitate, eaſily ſoluble in the liquor, and which did not deſtroy its viſcidity: the ſame circumſtance is obſerved, with the ſulphureous, nitric, muriatic and acetic acids. Diluted with from 12 to 15 times their weight of water, theſe acids impair the tranſparency of the ſynovia without deſtroying its viſcous conſiſtence; nevertheleſs, when weakened to ſuch a degree as to leave their acidity ſcarcely perſceptible, they cauſe the viſcoſity of this liquor to diſappear, render it clear and tranſparent, and ſeparate from it a ropy matter which may eaſily be obtained inſulated. The acetous acid eſpecially preſented this character, and he employed it for determining in this manner the proportion of the conſtituent principles of the ſynovia. 288 parts of this liquor extracted from the bullock gave him alſo 34 parts of ſtringy ſubſtance, afterwards 13 parts of albumen in pellicles obtained by evaporation, then 5 parts of muriate of ſoda

and 3 of acetite of ſoda; whence he concluded that it conained 233 parts of water.

9. But what moſt deſerves to engage our attention in this chemical inquiry is undoubtedly the nature of the ſtringy matter ſeparated from ſynovia by the addition of the weak acids, upon which Citizen Margueron has made ſome particular experiments. He has juſtly conſidered it as a particular circumſtance which does not preſent itſelf in any other animal liquor, and which conſequently deſerved to be ſtudied with ſome attention. Preſuming, from the properties which this ſubſtance preſented to him, that it could not be real albumen, though he afterwards deſignated in it the reſult of his analyſis as *albumen in a particular ſtate*, he wiſhed to aſcertain whether it might not be compared with the glutinous matter of wheat. He examined it under this new point of view, and he aſſures us that he did not remark any ſenſible difference of colour, taſte, or odour between theſe two fluids; their elaſticity and their adheſion to the fingers were the ſame; boiling water gave the ſame conſiſtence to both; the concentrated acids and alkalis diſſolved both equally. However he has obſerved differences between them; the ropy matter of the ſynovia diſſolves by agitation in cold water; this ſolution froths by agitation; the acids and alcohol precipitate it in flakes; caloric produces in it a very white and very rarefied ſcum. Theſe differences appeared to him ſufficiently conſiderable to induce him to

conclude from his examination that the ſtringy matter of the ſynovia was albumen in a particular ſtate. We here find a too manifeſt contradiction between the different aſſertions of the author: as he had ſaid ſome lines higher up that if it had been albumen, *the ſame means employed in order to obtain it from any other animal matter* would have preſented it *in a very different ſtate;* not to perceive the uncertainty and embarraſſment in which he found himſelf involved by the properties of this ſingular ſubſtance. Hence, I ſuſpect that this matter may really be very different from albumen, and that it deſerves to be examined anew with the greateſt attention.

10. The ſynovia affords very perceptible precipitates with lime water, as well as with the alkaline ſolutions of barites, of pot-aſh, of ſtrontian, and even with ammonia. The oxalic acid likewiſe produces in it a very ſenſible precipitation: all theſe effects manifeſtly proceed from the phoſphate of lime which it contains. Citizen Margueron found very ſenſible traces of ſalt in its coal; but he has neither determined its proportions nor diſcovered the mode of its ſolution in this liquor, in which however there is reaſon to believe that it is capable of performing an important function. The carbonates of pot-aſh and of ſoda unite very well with the ſynovia, without producing any change in its viſcidity; the cauſtic alkalis in ſufficient quantity render it more fluid, and even diſſolve

the

the ſynovia that has been dried by the contact of the air. This laſt mentioned character of the ſolubility of the ſynovia, when thickened by ſpontaneous evaporation in alkaline liquors, ſeems to announce in an incontrovertible manner the albuminous nature of this humour: however, we might draw this immediate concluſion; for, beſides the uncertainty in which the author of this analyſis has been involved by his experiments upon the fibrous part of the ſynovia precipitated by the weak acids, it is very evident that matters extraneous to albumen are ſoluble in the cauſtic alkalis. Beſides, the very facility or the complete ſtate of this ſolution that has been well remarked by Citizen Margueron, does not belong, at leaſt in this degree of energy, to albumen, and ſeem to indicate another matter, eſpecially an acid; and we ſhall ſee in one of the ſubſequent articles that there are ſome reaſons to ſuſpect the preſence of the uric acid in this particular liquor.

11. Alcohol precipitates the ſynovia without cauſing its viſcidity to diſappear. It ſeparates from it white flakes, inſoluble in the liquid, the nature of which Citizen Margueron has not indicated. The albuminous part of the ſynovia is certainly ſeparated by this re-agent, but muſt be allowed to believe that ſome other ſubſtance is at the ſame time precipitated, according to what the author of this inquiry has remarked. On adding acetous acid to the

mixture of ſynovia and alcohol the viſcidity of this mixture diſappears; there is ſeparated, he ſays, a matter ſimilar to that which he obtained from this liquor treated by the weak acids, and reſpecting the albuminous nature of which there is room for ſome objection, according to what I have already advanced. If this liquor contained uric acid or any of its ſaline combinations, the one or the other would certainly be ſeparated with a portion of albumen; the firſt as being little ſoluble in water or not at all ſoluble in alcohol, the ſecond as being coagulable by this re-agent. It is therefore well proved by this conſideration, as well as by all thoſe which I have detailed in the preceding numbers, that the analyſis of the ſynovia ſtill demands farther reſearches, and promiſes uſeful diſcoveries to ſuch chemiſts as may think fit to occupy themſelves with it.

12. Citizen Margueron had concluded from his analyſis that 288 parts of ſynovia which he had examined as far as to the proportion of its conſtituent materials, contained 34 parts of albumen *in a particular ſtate*, 13 parts of ordinary albumen, 5 parts of muriate of ſoda, 2 parts of carbonate of ſoda, from 1 to 2 parts of phoſphate of lime, and 232 parts, or more than three-fourths of its weight of water. I have explained the reaſons which induce me to think that this liquid contains, inſtead of the firſt of theſe materials, ſome particular animal ſubſtance, of a nature not yet ſuſpected, which

muſt have a more or leſs conſiderable relation with the diſeaſes which affect this liquor, eſpecially the Anchyloſis, the articular concretions, arthritic tophous humours, &c. Should this latter ſuppoſition be confirmed by new experiments, it will explain the differences which are already known between the humour of the internal membranes or of the interior membranous cavities, and that of the ſynovial capſules; it will prove that notwithſtanding the analogy of ſtructure which exiſts, and which I readily admit, with Citizen Xavier Bichat, between the ſynovial membranes and the other ſerous membranes, nature has intended, with the ſame organic apparatus, to give riſe to different products, and that we are not to infer, notwithſtanding the anatomical reſemblances, that the liquids ſeparated by analogous ſyſtems of organs muſt alſo reſemble each other, till after ſo accurate and ſo careful a chemical analyſis has been made, as to leave no room for doubt or uncertainty.

ARTICLE VII.

Of the cellular, membranous, tendinous, aponeurotic, ligamentous, glandular Textures, and of the Gelatin or the Glue which theſe Textures yield.

1. I COMPREHEND under a ſingle article ſix organic animal matters different from each other in their texture, their form, their appearances and their ſtructure, becauſe they are of the ſame chemical compoſition, and afford the ſame products in their analyſis. All theſe different textures are generally diffuſed in the bodies of man and of the other animals. There is not one of their different regions which does not preſent a greater or leſs quantity of them to the ſcalpel of the anatomiſt; ſo that they may be ranked in the claſs of parts that contribute the moſt univerſally to the organization. Each of them has both particular anatomical characters and particular uſes that diſtinguiſh it. The knowledge that has hitherto been acquired concerning their intimate nature and compoſition is undoubtly not ſo much advanced as that of their anatomical ſtructure; it is however ſufficient to approximate them to one another and to oppoſe them collectively in their chemical properties compared together to the other

animal matters. Let us caſt a haſty glance upon their ſtructure and characteriſtic differences, and afterwards ſee what they preſent in common with each other, in the phenomena which belong to their decompoſition and to the intimate nature of their conſtituent principles.

2. The cellular texture, which is alſo called *mucous, cribrous texture,* conſiſts of lamellæ, of thin, tranſparent, mucous or gelatiniform plates, of a delicacy which exceeds that of the fineſt gauze, and which may be compared with the light texture which dilated into a ſpherical form by a current of air blown into a ſolution of ſoap. Theſe laminæ are found between the interſticies of all the fibres; they are perceived when we ſeparate them; they connect them together, and at the ſame time ſeparate them from each other; they cannot be well ſeen except at the moment of this ſeparation; finally, they reſemble a gluey form extended upon the parts where they are obſerved. This texture, called the cellular, *tela celluloſa,* becauſe it was believed to conſiſt of cells opening into each other, forming a continued ſeries throughout the whole body, is in fact found in all its parts. It is ſituated under the ſkin in layers, more or leſs dilated by the fat, on the outſide of the muſcles and between their fibres, in the intervals which ſeparate them from the contiguous muſcles, along the blood-veſſels, around and even within all the viſcera. They are not ſmall balls or veſicles communicating freely with each other,

formed of ſoft and tranſparent membranes, as Bordeu thought, but reticulations of knotted and lymphatic veſſels, ſupported upon membranous laminæ, and containing a liquid moving in theſe ducts.

3. I here denominate membranous texture in general thoſe white, thin, tanſparent or opaque parts, extended into layers or kinds of tables, frequently folded together, rolled into cylindrical forms, applied in large laminæ, incloſing or covering the viſcera, forming ſometimes wholly or in part entire organs, exiſting throughout the whole body, and deſtined either to contain or to ſeparate and inſulate the different parts of the body, having only a white or dull grey aſpect, without brilliancy, without ſilvery ſurface, and never forming ſolid cords. Such are eſpecially the dura mater, the pia mater and the arachnoid tunic in the cranium, the pleura and pericardium in the thorax, the peritonæum in the abdomen, the ſides of the veſſels, eſpecially of the abſorbents; the perioſteum about the bones, the medullary membrane in their interior, the articular and mucous capſules, the vaginal and albuminous tunics and a multitude of other analogous parts. We might even claſs under the ſame head the epidermis and the ſkin, if theſe organs did not preſent certain properties which render it neceſſary for us to conſider them in particular.

Citizen Xavier Bichat has publiſhed, in the ſecond volume of the Medical Society of

Emulation, of Paris, a very good diſſertation upon the membranes and their general relations of organization. After having remarked that the anatomiſts have not ſufficiently generalized the ſtructure of theſe important parts, nor diſtinguiſhed their varied texture, he divides all the membranes of the human body into three claſſes: the *mucous*, the *ſerous*, and the *fibrous* membranes.

The firſt line the interior of the hollow organs which open upon the external ſurface of the body; folded or doubled into their internal ſurface, they are lubricated with a mucous juice; they are continuous with the ſkin: covered with an epidermis which detaches itſelf in ſhreds in ſome diſeaſes, their principal texture is formed of a ſpongy tunic which reſolves itſelf into cellular texture by diſſection, maceration, &c.; they are endowed with ſenſibility, and maintain the relations of the interior part of the body with extraneous ſubſtances, as the ſkin does of the exterior; they evacuate by their ſurface a mucous liquid, conſtitute a grand emunctory, have diſeaſes peculiar to themſelves, ſuch as catarrh and polypus, exhale the animal mucus by friction, irritation, and envelop the bodies which remain in them: ſuch are the interior of the inteſtines, of the vagina, &c.

The *ſerous* membranes occupy the large cavities, inveſt them, cover the viſcera placed on the outſide of them or in their folds, are facs without orifices, ſmooth at their internal ſurface and unequal at their external; they are lubricated in their cavity by a ſerum that is diſcharged by exhalation, and ſucked up again by the abſorbents; whereas the thick mucous of the firſt is always like an excretion, after it has been ſeparated by cryptous or mucous glands. They have their particular diſeaſes, eſpecially dropſy, adheſions, peculiar inflammations. They are laminæ or large ſacs which inſulate the viſcera, which may be conſidered as grand reſervoirs in which the lymph is elaborated, which favour the motion of the viſcera. In this order are to be ranked the pleura, the pericardium, the peritonæum, &c.

The *fibrous* membranes, which are leſs numerous than the two preceding, are hard, of a fibrous and white texture, perforated in order to ſuffer the veſſels to paſs through, &c. without folds, thicker than the ſerous, and leſs thick than the mucous membranes, without any liquid that moiſtens them, adhering in all their points, endowed with a particular ſenſibility and tenſion, elaſtic, frequently entering into the organs in which they form a fibrous ſkeleton, and the texture of which they ſupport. It is in this manner that the perioſteum inveſts the bones, the tunica albaginea, the teſticles, &c.

4. The tendinous texture is eaſy to be diſtinguiſhed; brilliant and ſilvery, ſmooth and poliſhed, conſiſtent and tenacious, ſtrongly reſiſting preſſure and extenſion, ſupporting a very

heavy weight before it breaks, formed into a denſe and ſolid cord, rounded or little angular, difficult to be cut, terminating the fleſhy fibres, and ſerving to fix their attachments to the bones, &c. The tendon is the cord, immoveable of itſelf, which, when drawn by the contracted muſcles, cauſes the bones to move one upon the other. It is in ſome reſpect merely a paſſive agent. It is very difficult to cut it acroſs or perpendicularly with the direction of its fibres; it is eaſily ſeparated into faſcia in the direction of their length. It almoſt always ſuppoſes the exiſtence of the muſcles, of which it is a kind of appendage.

5. The aponeuretic texture is a variety of form in the tendon: inſtead of being a hard and ſolid cord, the aponeuroſis is a kind of membrane which covers the fleſhy fibres; which frequently invelops the exterior of the muſcles, to the fibres of which it ſerves as a point of attachment, as a covering which limits their dilatation, as a link which retains their faſcia and their fibres adherent to each other. It is diſtinguiſhed by its fibrous, ſmooth, poliſhed, ſilvery, brilliant ſurface, which ſometimes imitates the luſtre of ſilver. It is an intertexture of flat, hard, cloſe fibres, which have ſeveral different directions, beſides that of the fleſhy fibres which they follow in one of their directions.

6. The ligament, as a particular texture, being ſituated almoſt always between the bones which

it ties together more or leſs ſtrongly, from which function it has derived its name, is found in the vicinity of the articulations, and exiſts in them all without diſtinction, conſequently throughout the whole continuity of the body. It is a compound of grey, ſolid fibres, very conſiſtent, very tenacious, very reſiſting, capable of being pretty conſiderably elongated and drawn without breaking, eaſily accommodating themſelves to all the motions which the articulations admit, permitting a certain ſeparation between the bones which form them, oppoſing their reciprocal diſplacement or luxations; ariſing between the laminæ of the oſſeous texture itſelf by filaments which are implanted there, connecting in the ſame manner ſome cartilages to the bones, or to each other.

7. Finally, I deſignate, by the name of glandular texture, the fibrous parenchyma interpoſed between the bundles of lymphatic veſſels, the intertexture of which conſtitutes the ſtructure of the conglobate glands. This has hitherto been ſaid to be cellular texture, but we need only diſſect theſe glands with ſome attention, and cut them in different directions, in order to be convinced that this notion is inaccurate. It muſt be remarked that I do not confound with the texture of the conglobate or lymphatic glands, which are found throughout the body, the parenchyma of ſome large conglomerate glands or glandular viſcera, ſuch as the liver, the ſpleen, the kidneys, &c.

Each of theſe viſcera has an intimate nature different the one from the other, as they are of a ſtructure peculiar to themſelves.

8. Theſe ten organic textures, without being perfectly of the ſame nature, preſent however, in moſt of the trials and experiments to which they are ſubjected, reſults ſufficiently ſimilar and related with each other, to authorize us to place them together, and to ſuppoſe in them an analogous general compoſition. All of them are inſoluble in cold water; and when we leave them to ſoak or macerate in it for ſome time, they become ſwelled, dilated, undergo a ſeparation between their fibres and their laminæ, become ſoft, mucous, eaſy to be torn, incoherent in proportion as they are altered. Moſt of them, fermenting with greater or leſs rapidity, when they are moiſtened or immerſed in water at a temperature that exceeds 12 degrees of the thermometer, paſs into an acid ſtate more or leſs pungent and ſenſible to the ſmell; ſo that we are tempted to conſider them as a kind of vinegar. All of them, after the firſt period of their ſpontaneous decompoſition, putrefy rapidly, and produce ammonia, which however is diſengaged from them in leſs abundance, and with a leſs fetid odour than is the caſe in other animal ſubſtances.

9. The ſame membranous and white animal matters, when expoſed to a conſtant mild fire, or to the contact of air at a degree of temperature exceeding 18 or 20 degrees become brittle

and tranſparent by drying: they are then unalterable. When they have thus become brittle, and have loſt all their tenacity, however, no other intimate change has taken place in them, except the volatilization of the water which their fibres contained, either ready formed, or compoſed at the very moment of the drying action of the caloric. A ſtronger heat briſkly applied to theſe dried organs cauſes them to ſhrink, to move, to contract in all directions, as we ſee in a violin-ſtring thrown upon burning coals; afterwards they melt, ſwell, inflame with difficulty, diffuſe an odour of little fetidity, and leave a pretty light coal eaſy to be incinerated. When we heat them in the retort, we obtain from them the ordinary products of animal matters, but leſs oil, leſs carbonate of ammonia, leſs fetid gas; in general, they appear the leaſt animalized of the animal compounds.

10. The moſt marked character, or the moſt characteriſtic property which theſe white textures preſent, is that of ſoftening quickly and diſſolving entirely in boiling water, and of forming, when this ſolution is ſufficiently charged, a liquid, viſcous and gluey fluid whilſt it is hot, which concretes into a tranſparent and tremulous jelly by cooling. It is in this manner, and with three or four of theſe textures at a time, that the Flemiſh or Engliſh ſtrong glues, as they are called, are prepared in various manufactories: the Flemiſh, after having cauſed theſe bodies to diſappear entirely, or al-

moſt entirely, by keeping them for a ſufficient length of time in boiling water, ſtrain it off clear, and evaporate it to ſuch a degree, that, by cooling, it acquires a perfectly ſolid conſiſtence. The alimentary jellies, which are alſo prepared in the kitchens, the tendereſt and moſt ſavory parts of theſe white textures being choſen for the purpoſe, are of the ſame nature, and differ from the glues only in the choice of the ſubſtance of which they are formed, and by the liquor being leſs thickened and concentrated.

11. We here recognize the ſame ſubſtance as that which has been found in the ſerum of the blood, coagulated by fire, and which diſtinguiſhes itſelf in it from the albuminous part with which it is mixed, by a ſemi-tranſparency, a ſoft and tremulous conſiſtence, and ſolubility in water: this is the gelatin. The properties preſented, when extracted by water, and in the ſtate of jelly, by this ſubſtance, which forms, as we have juſt ſeen, the baſe of the white fibrous or membranous textures, or organs, diſtinguiſh it in an eminent manner from albumen, from fibrin, and from every animal matter; its taſte is weak and faint; it feels mucous and gluey between the fingers, the temperature of which ſoftens it; it melts in the fire, and even becomes liquid at 36 degrees of temperature; it no longer preſerves its original viſcidity, does not adhere to the veſſels, but runs like water: when it has been left to

cool, it concretes into jelly, as before its fuſion, which has not altered it.

12. The gelatin extracted from the white organs, or textures, heated gently and ſlowly in the liquid form which the firſt impreſſion of the fire has given it, thickens, becomes coloured, viſcid, of the conſiſtence of honey, and at laſt aſſumes a concrete, ſolid, and tranſparent form, ſimilar to horn. It is then glue, which is hard, elaſtic, of an orange-yellow, or red colour, brittle, ſoluble in boiling water, and which, in general, acquires the more ſolidity, colour, and glutinous tenacity by its ſolution, as it has been extracted from older or more robuſt animals. When we ſubject it to decompoſition by the fire in a retort, we obtain from it an ammoniacal water, a fetid oil of little thickneſs, zoonate of ammonia and ammoniacal carbonate; it affords little gaſeous product. The coal which it leaves is light, voluminous, and porous; eaſy to be burned, affording neither ſoluble phoſphoric ſalt nor metals, but only phoſphate of lime and muriates of ſoda and pot-aſh. The gelatin becomes ſenſibly acid before it paſſes into putrefaction, and affords ammonia.

13. Cold water diſſolves it, by being continually agitated with it for ſome time; hot water immediately melts it, when its temperature exceeds 25 degrees; and this is the reaſon why jellies cannot be made to aſſume the proper conſiſtence in the ſummer without the ut-

moſt difficulty. When the gelatin has been diſſolved in a large quantity of water, it can no longer become fixed into a jelly by cooling, and it is neceſſary that this too dilute ſolution ſhould be evaporated, in order to reſtore to it this property; it is always made to loſe this property of aſſuming the gelatinous form by refrigeration, in proportion as we multiply the action of the caloric, or expoſe it too many times to the fire. The acids, even the weakeſt, diſſolve the gelatinous matter very eaſily and ſpeedily. The alkalis, likewiſe, poſſeſs this property, but in a leſs marked degree than the acids. The nitric acid diſengages but very little azotic gas from the gelatin, and changes only a very ſmall portion into fat, but the greater part into oxalic acid; the ſolutions of barites, of lime, and of ſtrontian, poured into a ſolution of gelatin, produce in it a precipitate of phoſphate of lime.

14. Several of the properties that have hitherto been deſcribed in the gelatin, and eſpecially its form, its tranſparency in the ſtate of jelly, its aceſcence; the ſmall quantity of ammonia, of oil, and of fetid gaſes, which it affords by the action of fire; the ſmall quantity of azotic gas, and oily ſubſtance which is extracted from it by the nitric acid, which converts a great part of it into oxalic acid; its rare and ſwelled coal, are in favour of the opinion of thoſe who conſidered this matter as having much analogy with the vegetable mucilages, and who be-

lieved it to proceed from the mucous vegetable ſubſtance, that had paſſed almoſt unchanged into the body of the animal. This, however, is a hypotheſis which will appear little probable to thoſe who conſider that the nature of every aliment is changed, from its reception into the ſtomach till its lamellous or fibrous application to the different organic textures which it is deſtined to nouriſh; and beſides, notwithſtanding this analogy between the gelatin and vegetable mucilage, properly ſo called, there exiſts a real difference which ſhows itſelf in the putrefaction, of which the firſt is ſuſceptible, but not the other.

15. A ſtill greater difference is conſtituted by the manner in which tannin acts upon gelatin, whereas it produces no effect upon the vegetable gummy mucilage: when we pour into a ſolution of animal jelly or glue, water charged with tannin, it produces a precipitate of a fawn-yellow colour, thick, in very fine flakes, which ſuddenly approach each other, and ſoon form a ropy, glutinous, elaſtic maſs, extenſible by agitation, kneading in the moiſt hands, like the gluten of the flower of wheat. This compound of tanned gelatin is dried by the contact of the air, becomes hard, brittle, of a ſmooth texture, brilliant, vitreous, and reſinous in its fracture; it is inſoluble in water, unalterable in the air; it reſiſts many agents and re-agents; it is incorruptible, analogous to ſkins that have been too much tanned, and

when it is rubbed it exhales a ſtrong tanny odour; it may be conſidered as a paſte, ſuſceptible of being employed for different uſes, and of which the induſtrious arts might avail themſelves with great advantage, if they ſhould occupy themſelves with it.

16. Finally, the animal gelatinous matter comports itſelf alſo in a very particular manner with alcohol, which does not diſſolve it when it is in the form of jelly extracted by water, but even ſeparates it from this liquid when its ſolution is concentrated, which condenſes its fibres or laminæ, when they belong even to the organs, the texture of which they in a great meaſure conſtitute: ſo that theſe organs, immerſed in alcohol, are preſerved and condenſed in it, without loſing any thing of their form and ſtructure, except a ſmall portion of their diameter. This is exemplified in the membranous organs dreſſed, diſſected, and prepared anatomically, and afterwards ſuſpended by threads in bottles filled with alcohol: however, this method of preſerving them in the anatomical collections has only a certain period of duration, and at laſt ſuffers an intimate change to take place in their texture, which ſeparates from it laminæ, foliations and fibres, the precipitation of which we obſerve at the bottom of the veſſels in which they are contained.

17. Though I conſider the ſix white organic textures as belonging to a ſingle matter, to a ſingle gelatinous chemical compound, the diſ-

tinguiſhing character of which is to be inſoluble in cold, but ſoluble in boiling water, ſo as to give riſe to what is called an animal jelly; this notion is, however, not to be underſtood in too rigorous a ſenſe; neither ought we to conſider theſe ſix textures as intirely and perfectly homogeneous. The mere difference of their reſpective form, aſpect, colour, ſtructure, denſity, and tenacity, would ſufficiently contradict this pretended identity. Though the chemical anlayſes, which have not yet been ſufficiently multiplied, have not yet led to a ſufficiently accurate determination of the circumſtances in which the mode of their diverſity, ſo apparent to the anatomiſt and phyſiologiſt, conſiſts; however little advanced this analyſis may as yet be, we may nevertheleſs find in their compariſon and in their reſult, eſpecially when we call to our aſſiſtance thoſe preſented by the arts that are exerciſed upon theſe ſubſtances, a ſeries of facts ſufficiently intereſting to eſtabliſh ſome uſeful diſtinctions between theſe different textures, and to ſatisfy the anatomiſt, who cannot, from his diſſections, be perſuaded of this pretended identity of organs, which to him are really very different. It therefore remains for me to remark the varied modifications of chemical nature between the ſix kinds of textures, which I have hitherto preſented only as being of a ſimilar gelatinous nature.

18. The very light and froth-like lamellæ of the cellular, or mucous texture, preſent the gelatinous matter in the pureſt, the moſt inſulated and the moſt marked ſtate; of this we may convince ourſelves, by the mere conſideration of what happens to them by their action in boiling water. Theſe lamellæ diſſolve and melt ſo completely, that they diſappear in the water of theſe decoctions, and all the fibres which they connected together are afterwards found ſeparated, incoherent, naked, deſtitute of the integument which enveloped them on all ſides, and the water thus performs a kind of diſſection, which is frequently of uſe to the anatomiſt in his diſſections. It is the ſolution of this texture accompanying the fleſh which gives to certain broths the property of concreting into a jelly.

19. The textures of thin white tranſparent membranes, ſuch as the pia mater, the arachnoid tunic, the epiploon; thoſe of ſtronger membranes, as the ſubſtance of the peritonæum, of the pleura, of the pericardium, part of the tunics of the ſtomach and of the inteſtines, the perioſteum, differ a little from the cellular lamellæ properly ſo called; though anatomiſts have believed them to be formed of theſe lamellæ united and condenſed, from the circumſtance that water does not attack them, except with much greater difficulty and with the aid of a longer ſpace of time. In order to

diſſolve them it is neceſſary to let them macerate for ſeveral days in warm water, to ſeparate the lamellæ and fill their interſtices with the aqueous liquid, and afterwards to boil them for a long time in a large quantity of water, and keep them immerſed in it, agitating them inceſſantly. We ſhould affirm that the gelatin is not ſo pure in it, that it is inveloped, as it were, in an inſoluble and tenacious ſubſtance which prevents its fuſion. The manufacturers of glue are well aware of this difficulty; the animal matter is ſufficiently denſe, ſufficiently compact in theſe organs, to dry in the air when theſe membraneous parts are thin and extended, as is exemplified in the art of making cat-gut ſtrings. We may alſo combine ſlowly, particle by particle, the ſubſtance of this texture with tannin; and at ſome future time advantage will be derived from this kind of tanning of membranes or inteſtines, by keeping them for ſome hours immerſed in a ſolution of tan, in order to communicate to them a greater ſolidity and an uſeful inalterability, at the ſame time preſerving their tenacity and elaſticity. For the reſt, Chemical analyſis has not exactly determined in what this difference between the membraneous texture properly ſo called and the cellular texture conſiſts; but it is now in progreſs towards determining it.

20. The tendons and the aponeuroſes, which are flat tendons, though conſiſting of ſolid cords or very tenacious layers, approach more

to the cellular texture properly ſo called. It is remarked in the boiled meat which is ſerved up at our tables: all its tendinous and aponeurotic parts are melted or ſoftened, when they are well boiled, into a ſort of yellowiſh, tranſparent, gelatinous glue, which ſome perſons prefer, and which in fact has a ſufficiently agreeable taſte. In the preparation of glues, all the tendons are melted and diſappear intirely in the water; they even form the major part of the gluey ſubſtance, and give to water that conſiſtence and viſcidity, from whence jelly is produced by cooling. When the tendons, being drawn out and extended in order to make them preſent a larger ſurface to the air, are dried, they become tranſparent and ſolid, and at the ſame time acquire a yellow or reddiſh colour, as we ſee in dry anatomical preparations.

21. The ligamentous texture, though it alſo contains gelatin which is extracted from it by boiling water, is nevertheleſs of all the white organs that which partakes the leaſt of the gelatinous nature. The familiar and domeſtic fact of the meat boiled in our aliments proves this in a direct manner. At the ſide of a tendon that has been ſoftened and melted into jelly we frequently ſee upon our tables a cord, generally flat and thick, of a white opaque matter, hardly at all ſoftened, and of ſuch tenacity and hardneſs that it is impoſſible for the teeth to attack it, and which cannot be eaten, on account of its exceſſive reſiſtance to

maſtication. This very remarkable want of ſolution, at the ſide of membranes of the ſame fleſh, ſoftened and diſſolved in the ſame water and in the ſame of time, announces not only that the ligamentous texture is much more denſe than that of the other white parts, but that it is probably of another nature; reſpecting which chemiſtry has not yet decided. The ſame is the caſe with the membranous coats of the arteries and veins. Beſides the fleſhy fibrils and the cellular layers which form a part of them, there is in their texture a matter analogous to the ligament, which reſiſts the action of boiling water, and is not converted into gelatin like the preceding textures: it is poſſible that this matter might be formed by the fibrin; but we have no fact that proves it with the accuracy requiſite to authorize us to admit the reſult. This texture of the blood-veſſels is extremely different from that of the lymphatic veſſels: the latter though ſufficiently hard and reſiſting in proportion to its extreme tenuity, nevertheleſs melts pretty quickly in water and forms jelly, as we ſee in the laminæ of the cellular texture, which modern anatomiſts have diſcovered to be a tiſſue of abſorbent veſſels.

22. I muſt obſerve the ſame of the texture of the conglobate glands, deſignated by anatomiſts as bundles of lymphatic veſſels folded together and united with each other by cellular texture. Were this its real nature and ſtructure, this texture would ſoften and melt intirely in water, to

which it would impart the gelatinous character. However, inſtead of diſſolving in this manner, though they do yield a little jelly, the conglobate glands harden and reſiſt the action of a large quantity of boiling water. This reſiſtance is ſtill more conſiderable in the texture of ſuch of theſe glands as have acquired a more or leſs conſiderable enlargement, and a greater or leſs degree of induration, in the chronic affections that have been deſignated in ſo improper, or at leaſt in ſo vague a manner, by the name of obſtructions, as we find them in perſons afflicted with ſcrophula, &c.

23. Finally, the texture of the ſkin, which has always been compared with that of the preceding white, ſoft, and membranous organs in general, and which in fact preſents a very ſtriking analogy with them, has however very conſiderable differences from them; beſides which, the important uſes for which it is deſtined, and the remarkable utility which it has in many of the arts, have induced me to treat of it in particular.

24. Neither ſhall I ſpeak here of the nervous texture diffuſed throughout the whole body, as it will more naturally require to be conſidered under the article concerning the brain.

ARTICLE VIII.

Of the Muſcular or Fleſhy Texture.

1. THE white, ſoft, and membranous textures in general, which have been deſcribed in the preceding article, form collectively a claſs of organic matters well characterized and well diſtinguiſhed from all others; and by ranking it as the firſt in the order of the general ſolid textures, or of thoſe belonging to the whole body of animals, or which are found diſtinctly in all its regions, I obſerve that we muſt refer to three other claſſes all the different matters which embrace the ſame univerſality of organiſm, or contribute to the general conſtruction of all the organs of animals. I place in the ſecond claſs the muſcular or fleſhy texture, in the third the horny texture, and in the fourth the intirely ſolid or oſſeous texture. The preſent article is deſtined for the hiſtory of the muſcular texture.

2. The muſcles, which in their totality and generality comprehend the fleſhy or muſcular texture, are one of the moſt important and moſt uſeful claſſes of organs in the animated machine; in them and by them it is that the power of life executes the different motions which maintain it, or which inceſſantly ſupply

its wants; it is by means of their contraction, of the irritability or the force which produces this contraction, this ſhortening of the fibres which brings together thoſe ſubſtances to which they are attached, that the animal moves, tranſports itſelf in ſpace, ſlowly traverſes the ſurface of the earth, bounds to ſome diſtance from this ſurface, riſes, or ſupports itſelf in the atmoſphere, advances, deſcends, riſes or dives in the water; it is theſe which execute the intermitting and concealed motions which conſtitute life, ſtanding, walking, vaulting, flying, ſwimming, the flexion, the extenſion of the different parts, or the ſenſible action of partial or total locomotion, ſubjected to the will or thoſe paſſions which ſo eminently diſtinguiſh the claſs of organized and animated beings from that of the plants.

3. When we conſider the muſcles in their relations with the other parts of the body of animals, we find in them a new motive of intereſt for ſtudying their properties, becauſe the muſcular ſyſtem forms one of the moſt conſiderable maſſes of the animal organization. Their totality occupies a very large ſpace in the economy of the animal: covered by the ſkin, contained in aponeuroſes, covering on all ſides the bones which they invelop and adorn, it is they that give form and toroſity to the members. Their projecting and protuberant parts, together with the depreſſions of their intervals, diſplay all the forms which

the ſtatuary and the painter imitate in their moſt finiſhed works, by the aid of which they preſent to our eyes the majeſty of a god in the Apollo, the expreſſion of anguiſh in the Lacoon, invincible ſtrength in Hercules, vigour and dexterity in the wreſtler, the bloom of youth in the Antinoüs, or grace and beauty in the Venus.

4. The muſcles are ſupplied with liquids by a great number of blood-veſſels, which wind along their ſurface, and enter amongſt their fibres, by lymphatic veſſels which are alſo ſituated round their fibres and in the interſtices which ſeparate them. We find in them nerves which are diſtributed, and loſe themſelves in their faſciæ; cellular texture with which they are abundantly provided, aponeurotic membranes which ſurround them, tendons which terminate them. Though all theſe parts are only acceſſary to their texture properly ſo called, anatomiſts conſider them as belonging to their organization, and in fact they all contribute to their functions: the cellular texture connects their fibres; the blood-veſſels nouriſh and warm them; the abſorbent veſſels take up the ſuperfluity of their nouriſhment, and carry off the parts that are worn by the vital actions; the nerves convey into them the immediate cauſe of their motions, and the order of the will which commands them, of whatever nature this cauſe may be; the tendons determine their action upon ſuch or ſuch parts; the aponeu-

roſes afford a point of ſupport to their faſciæ. There is alſo fat both on the outſide and in the inſide of their fibres, which are thereby enabled to ſlide eaſily upon one another. The totality and the integrity of theſe different textures, which penetrate them and conſtitute them living organs, are neceſſary to the exerciſe of their functions; and when the one or the other is deficient or ſuffers, the muſcle loſes a part or the whole of its activity: on this account ſome of the anatomiſts have ſuppoſed the muſcles to be formed of cellular texture; others have believed them to be conſtituted of nervous filaments; and ſome have conſidered them only as vaſcular extremities.

5. The analyſis of the muſcles provided with all the organic parts which conſtitute their totality is not, therefore, nor can it be, exact, ſince it confounds a great number of different textures together. If it were true that ſuch was the contexture and the compoſition of theſe organs of motion, we could not flatter ourſelves with the hope of being able to aſcertain their nature, except by the analyſis of each of theſe parts; and when once each of them was well known, nothing more would remain to be done in order to determine that of the muſcle. Formerly the analyſis was confined to the diſtilling of the fleſh, and deſignating the quantity of phlegm, of ſpirit, of volatile ſalt, of oil and of coal which it afforded: we muſt add to this ancient notion, that amongſt the

products of the fleſh we obtain a remarkable quantity of zoonic acid combined with ammonia, and that the muſcle appears to be amongſt the animal ſubſtances that which furniſhes the moſt of this acid. Geoffroy, the phyſician, has deſcribed the effect of water, and quantity of ſoluble matter which it takes up by ebullition from a great number of different ſorts of fleſh, with reſpect to the nutritious matter contained in each of them. This inquiry is of no value, except with reſpect to the alimentary property. Thouvenel was the firſt who endeavoured to aſcertain the different principles, or rather the conſtituent materials of the muſcles; for this purpoſe he employed ſeveral proceſſes which had not been practiſed before him, and which enabled him to give a rather more accurate notion of the nature of theſe organs. I have ſince occupied myſelf with the baſe itſelf, or with the parenchyma peculiar to the muſcles, and conſequently with their real texture, independent of all the ſubſtances that are only acceſſary to it.

6. While it is impoſſible to inſulate the muſcular texture properly ſo called from the vaſcular and nervous textures, from the ſanguineous, lymphatic, adipoſe liquids that are intimately mixed with it, we muſt content ourſelves, in treating of the chemical properties of the muſcle, with inveſtigating and ſeparating thoſe which belong to each of thoſe animal matters in particular, and attributing to the

muſcular fleſh thoſe only which do not characterize theſe matters. This method of excluſion may lead, as we ſhall ſoon ſee, to a ſomewhat accurate knowledge of the nature of the fleſhy fibre. Modern chemiſts have treated the muſcle like a vegetable matter mixed with ſeveral different ſubſtances, which they have endeavoured to ſeparate from one another, firſt by mechanical means, afterwards by chemical proceſſes. As the organ is filled with ſanguineous and lymphatic veſſels, which contain liquids, Thouvenel employed the action of the preſs for ſeparating them. The fluids which he obtained were treated ſucceſſively by caloric, which coagulated their albuminous matter, and cauſed their ſalts to cryſtallize by evaporation; and by alcohol, which diſſolved ſome of their ſalts, and a particular extractive ſubſtance, which this chemiſt believed to be peculiar to the muſcles. He made different ſucceſſive applications of water to the reſiduum of the firſt evaporated liquid, in order to ſeparate from it the gelatin and the ſalts; but theſe means did not conduct him to his end ſo exactly as he had hoped; and in fact they preſent great difficulty in the execution.

7. I have ſucceeded better in this analyſis by firſt waſhing the muſcle in cold water, which carries away the blood and the lymph, and which when the fleſh has been cut ſmall and worked with water poured in a ſtream upon its ſurface, ſoon leaves the white muſcular tex-

ture inſulated, mixed indeed with vaſcular tubes, nervous filaments, cellular laminæ of which we may afterwards effect a kind of ſeparation by the aid of the proceſs which I ſhall indicate. The water which has waſhed and diſcoloured the fleſh perfectly reſembles blood diluted with water; if we heat it, it coagulates and ſeparates at its ſurface in browniſh-red flakes, as happens with the colouring part of the blood; at the ſame time there are depoſited fibrous filaments, in ſmall quantity indeed, but which may be diſtinguiſhed to be fibrin. The liquor (which is little coloured after this action of the fire, and is ſlightly turbid and milky) when gently evaporated, affords albuminous pellicles, which are ſeparated, becomes coloured, acquires a taſte ſomewhat acrid when it is concentrated, concretes into a light jelly by cooling, and affords, when evaporated to dryneſs, a reſiduum of a brown-red colour, from which we obtain, by a well-conducted application of alcohol and water employed ſucceſſively, a ſort of ſapid extract of which I ſhall ſoon ſpeak, with a ſmall quantity of gelatin, and phoſphates of a ſoda and of ammonia.

8. We ſee that cold water applied to fleſh extracts from it, together with the ſanguineous and lymphatic liquor, a ſmall portion of extractive and ſapid matter, which belongs peculiarly to this organ. When the fleſh is thus deprived of what it contained of matter ſoluble in cold water; if we boil it in water, it ſtill ſuffers an

albuminous ſubſtance to eſcape, which is collected into greyiſh flakes at the top of the liquor, and alſo a ſubſtance which floats like drops of oil at its ſurface. The fleſhy fibres ſeparate from each other, and the diſſolved lymphatic and cellular texture give the water the property of concreting into a jelly by cooling. A well-managed evaporation of this decoction of fleſh previouſly diſcoloured, ſtill exhibits a portion of ſaponaceous extractive matter, which acquires colour by concentration, with ſome traces of phoſphoric ſalts. The product of this decoction is a kind of bad ſoup, which has not all the properties of that which is prepared with the intire and unwaſhed fleſh, of which we ſhall ſoon ſpeak: however, it differs from it only by its containing fewer principles.

9. After theſe two ſucceſſive actions, firſt of cold water, and afterwards of boiling water upon the muſcles, if each of them has been carried as far as it can go, there remains only a fibrous parenchyma, of a dirty grey colour, and inſipid, which ſo far from diſſolving in hot water becomes hardened by its action; which dries and becomes brittle in dry and hot air, and preſents all the characters of the fibrin of the blood, eſpecially its ſolubility in the weak acids, the property of yielding by the fire much ammoniacal carbonate and a fetid oil; that of affording azotic gas in abundance by the action of the nitric acid, which converts it into yellow fat floating at the ſurface, and

oxalic acid diſſolved in the liquor. I have concluded, from my reſearches concerning this fleſhy parenchyma, that it is formed immediately by the blood poured ſo abundantly by nature into the texture of the muſcle; that the nutrition of this organ conſiſts in the ſeparation of the fibrin; that it is undoubtedly on this account, that not only the blood is very abundant in it, but that it is alſo retarded in its courſe before it penetrates into the interior of the fibres, by curvatures and tortuoſities; ſince, according to the celebrated Haller, a great number of arteries purſue a tortuous and retrograde courſe, before they plunge themſelves deep into the muſcles. It is under this relation that I have repreſented the blood as liquid fleſh, according to the expreſſion of the Father of medicine.

10. When fleſh is boiled in water without previouſly waſhing it, a large portion of the ſerous and coloured albuminous matter ſeparates in brown flakes, coagulated by the action of the heat, and forms the ſcum which is taken off; another portion of the ſame matter remains adhering to the fleſh, and gives it that browniſh fawn colour which, as is generally obſerved, becomes darker by the contact of the air: the water gradually diſſolves the gelatinous matter belonging to the cellular and lymphatic texture of the muſcles, melts and ſeparates the fat which ſwims at the ſurface, diſſolves both the phoſphoric ſalts, and a par-

ticular extractive matter, which gives it the clear yellow colour, the aromatic odour, and the rather pungent and agreeable taſte, which every one knows in fleſh broth. This alimentary liquor, therefore, when well prepared, is a ſolution of gelatinous matter, of an extractive animal ſubſtance, of phoſphate and of muriate of ſoda and of ammonia; it moreover contains a ſmall quantity of fatty oil, diſſolved by the aid of the gelatin and of the extract, a ſmall quantity of albuminous matter, and even a ſmall portion of phoſphate of lime.

11. Fleſh broth preſents to chemical examination a ſeries of phenomena, which prove the preſence of theſe different matters. This liquid is ſuſceptible of turning ſour in hot ſeaſons, on account of the gelatinous matter which it contains; acetous acid is then formed in it. Lime-water, or ammonia, produces in it a ſlight precipitate of phoſphate of lime in a white powder; the oxalic acid ſhows the lime it contains by the white depoſition which it occaſions in it; nitrate of ſilver indicates the preſence of muriatic acid; the nitrate of mercury occaſions a white precipitate, which acquires a roſe-colour by drying in the air, and is a mixture of mercurial phoſphate and muriate, coloured by an animal matter. When we ſlowly evaporate the fleſh broth, it aſſumes an orange and brown-red colour, a ſtronger conſiſtence, and a ſomewhat acrid taſte; and, in this ſtate, it is called (in French) *conſommé.*

Moſt of the ſoups reduced to this ſtate congeal, by cooling, into a tremulous jelly; thoſe which are made with the fleſh of young animals preſent it the ſooneſt, on account of the large quantity of gelatin which they contain. By continuing the action of a gentle fire, we obtain, after a more and more decided inſpiſſation, a matter which becomes ſolid by cooling, of a brown-red colour, having a ſtrong and acrid taſte, which keeps for a long time without alteration, which melts intirely in hot water, and forms a ſoup which conſiderably reſembles that which is originally made with the fleſh; this is what is called *extract, or tablets of ſoup*, (portable ſoup) becauſe this ſubſtance is poured into the moulds of tin, in which it aſſumes the form of tablets. If we diſtil this extract of broth, beſides the products common to other animal matters, we obtain a conſiderable quantity of zoonate of ammonia.

12. When the extract, or portable ſoup, is prepared for the uſes of life, and for voyages, the pcoceſs is not confined to making a ſoup of ſimple fleſh. The fleſh of the bullock, the calf, and of poultry, are mixed together; to theſe are added ſavoury vegetables, carrots, onions, cellery, ſome ſpices, eſpecially cloves, with muriate of ſoda in ſufficient quantity, ſo that it actually becomes a mixture of ſeveral different extracts, ſeaſoned with ſaline and aromatic matters, mixed with the portion

of ſaccharine matter contained in the vegetables. Accordingly they have a ſtrong taſte, and a lively ſmell, different from that of mere boiled meat. The portable ſoup keeps for a pretty conſiderable time. However, it becomes altered after ſome years; it becomes covered with a white ſaline efflorefcence; it attracts humidity, and ſoftens and becomes mouldy at its ſurface. The true and pure extract of meat would be neither ſavoury nor agreeable, in compariſon with that of which I have been ſpeaking: it is, however, this extract whoſe properties we muſt examine, in order to make ourſelves acquainted with one of the principal materials of muſcular fleſh.

13. The extractive matter taken up from the muſcle by boiling water, is obtained by lixiviating the product of the ſoup, evaporated to the conſiſtence of thick honey, with alcohol: this re-agent attacks neither the gelatin nor the moſt of the ſalts contained in this product. By evaporating this alcohol, which is highly coloured, we obtain a brown-red matter, of a pungent and even acrid taſte, and of a particular aromatic odour; when heated a little more ſtrongly than is requiſite for drying it, it boils and ſwells, and aſſumes the ſmell and ſaccharine taſte of caramel: it appears that it is this which forms upon roaſt meat that brown, ſhining, and highly ſapid incruſtation, which is called the *brown (riſſolé).* This extract remains ſoft in the air, and gives the portable

ſoup its deliqueſcent property. Heated ſtrongly upon a burning coal, it becomes liquefied, ſwells, exhales a white ſmoke, and an acid ſmell. Diſtilled in the retort, it affords water containing zoonic acid and zoonate of ammonia. Its coal contains muriates of ſoda and of pot-aſh; diſſolved in water, it gives it a deep red colour: this ſolution becomes ſour in the air, and partly paſſes into the ſtate of vinegar, depoſiting ſome coal. It ſtill remains to be determined, whether this kind of extract be contained ready formed in the muſcular fleſh, or whether it be not produced by the decompoſition of the fibrous texture, effected by the action of the caloric.

14. The different facts relative to the analyſis of the muſcular texture, which have juſt been enunciated, ſerve to account for what happens to the muſcle, when it is expoſed to the action of different agents in its intire ſtate, and without the different materials having been ſeparated from it. We may thus underſtand, that in the baking or roaſting of meat, the albumen is condenſed, the gelatin melted, the extract dried, the fibrin penetrated with juice is rendered tender, the ſalts are concentrated, and the fleſh, whilſt it aſſumes a brown colour, acquires a taſte and properties very different from thoſe which it has in its crude ſtate. If, inſtead of heating the fleſh ſtrongly enough, and for a ſufficient length of time to bake or roaſt it, we heat it but very ſlightly, and ſo as only to

evaporate the water contained in it, it dries, becomes coloured, brittle, and may afterwards be preſerved for a long time. The acids ſoften the muſcle, and diſſolve it by acting upon its fibrous part. The concentrated cauſtic alkalis alter, melt, and diſſolve it, forming ammonia and oil, with which they conſtitute a kind of ſoap. Ammonia produces no perceptible change in it.

15. Many ſaline ſubſtances preſerve the muſcular fleſh, and prevent its putrefaction. Thus muſcular anatomical preparations are immerſed in a ſolution of alum, in which, however, the fleſh is at laſt altered and converted into a kind of fat. Fixed oil, the butters, and the fats, with which it may be ſurrounded, or covered, contribute to preſerve it; the volatile oils, the reſins, the odorous woods, the bitter and aromatic leaves and barks, act alſo as anti-putreſcent, and prevent the ſeptic decompoſition of this texture. Tannin diſſolved in water alſo penetrates its fibres, precipitates in them the gelatinous matter, and ſurrounds them with a layer of tanned matter, which equally oppoſes their putrefaction. Alcohol contracts and condenſes its texture, ſo that it cannot afterwards undergo that kind of ſpontaneous alteration which tends to deſtroy its compoſition.

16. The muſcle left expoſed to the air, putrefies very quickly, when the temperature of the atmoſphere exceeds 15 degrees. Its component parts at firſt exhale a faint or muſty ſmell; it

acquires a livid colour, which grows darker in proportion as the putrid decompoſition advances; its texture ſoftens and melts at the ſurface into a kind of liquid putrilage; the ſmell becomes fetid, ſtrong, and ammoniacal; ſometimes there is diſengaged at its ſurface a phoſphoric light, which ſhines both in water and in the air, and ſubſiſts for ſeveral ſucceſſive days. When the whole of the fleſh has been equally ſoftened, diſſolved, and turned green by putrefaction, it at laſt leaves, continually exhaling a fetid odour, a brown or blackiſh reſiduum, which, for a long time, is ſoft and moiſt, but dries after ſeveral months into a kind of animal mould, in which we find ſome traces of fat, of carbon, and of alkaline phoſphate and muriate. When the muſcular fleſh experiences the putrefactive motion, after having been immerſed in water, its decompoſition gives riſe to another product. There is formed a fatty, white, fuſible matter, conſiderably reſembling what is called *ſpermaceti*, and which I have already deſignated by the name of *adipocire*. This phenomena takes place ſo conſtantly, as I firſt obſerved fourteen years ago, in all the muſcles of the carcaſes of animals expoſed upon the borders of rivers, brooks, and lakes, that I have propoſed its re-production in order to procure, from animal remains that are generally thrown away in the country, and even in large towns, a kind of fat which may be of uſe in ſeveral of the arts. It was undoubtedly from this propoſal that Mr. Gibbes has deſcribed this new art in the volume of the Royal Society of London, for the year 1797.

17. It ſtill belongs to the province of chemiſtry to determine the changes which the muſcles experience in different kinds of diſeaſes which attack their texture, and at the ſame time alter their intimate nature or compoſition. This art will ſhow what happens to them in the diminution of their alterability, in the ſoftneſs which they ſometimes acquire, and which renders them very eaſy to be torn, in their acquiring the bright red or light brown colour, which characterizes them in the courſe of other affections, and eſpecially in the white colour, and fatty unctuous aſpect which they contract in the courſe of long continued paralytic immobility and inſenſibility.

18. The difference of the muſcles in the different orders of animals is alſo one of the moſt important objects of chemical reſearch for the animal philoſophy, but unfortunately one of the leaſt advanced; for we can ſcarcely reckon amongſt theſe reſearches the firſt experiments made more than ſixty years ago by Geoffroy upon the nutritive quality of different kinds of fleſh compared with each other. The object of chemical analyſis ought to be to reſolve the following queſtions, the ſolution of which can be expected from this alone. In what does the muſcular fleſh of the mammalia of the chaſe, characterized under the name of

black meat or *veniſon* by its brown or dark red colour, differ from that of the ordinary mammalia? Are the muſcles of the carnivorous animals different from thoſe of the frugivorous? How does the compoſition of the fleſh of young animals differ from that of the ſame animals more advanced in age? Is the white fleſh of birds of a different nature from that of the mammalia and from that of the birds with black and odorous fleſh, as well as from the oily and hard fleſh of water-fowl? What is the comparative nature of the fleſh of fiſhes, both in the cartilaginous and in the prickly ſpecies, of that of the ſea and of freſh-water fiſhes, of that of the oviparous quadrupeds, of ſerpents, of inſects, and of the teſtacea? All theſe queſtions, and many others to which theſe will naturally lead, are adapted to throw the greateſt light upon the phenomena of life, of irritability, of the tonic force, &c.

ARTICLE IX.

Of the Dermoid Texture, or of the Skin, and of the Epidermoid Texture, or the Epidermis.

1. THE body of the greater number of animals is inveloped, and all its organs are covered by ſeveral layers of different membranes,

which are called in general teguments. In man, in whom this cutaneous covering is the moſt perfect and the beſt organized, as it is not only deſtined to contain all the other parts, but alſo to form the ſeat of the ſenſe of touch, which is more or leſs deficient in moſt of the animals; the teguments are compoſed of three membranes or three ſucceſſive layers; the innermoſt, that which is applied immediately upon the fatty cellular texture, is the thickeſt, the ſtrongeſt, the moſt reſiſting: it is the ſkin properly ſo called, or the derma. Above and on the outſide of this firſt tegument is a ſoft, cellular, areolar, mucous layer, formed of a thin net-work, the meſhes of which are filled with a kind of gelatinous texture, in the midſt of which are placed as upon cuſhions, the papillary extremities of the nerves, the ſeat of the touch: this ſecond layer is the reticular texture of Malphighi. Finally, on the outſide of and above this ſecond texture, is applied a fine, tranſparent membrane, dry externally, which covers the nerves, and is known by the name of epidermis. In the animals this laſt covering varies greatly; there is beſides, under the ſkin, a flat muſcle, generally diffuſed over the whole body, which is called the *fleſhy panicula.*

2. Theſe three ſucceſſive teguments differ in the different parts of the body; they are fine and delicate in ſome parts, thicker, and more ſolid in others. The nerves of touch in man

are more multiplied and of a more elegant, more regular, and more diſtinct ſtructure at the extremities of the fingers. The derma is in general and in all animals extenſible, perforated with holes which permit the nerves, the hairs, and the extremities of the arteries to paſs through; it varies greatly with reſpect to its thickneſs, its elaſticity, its tenacity, in the animals of different orders and genera. The reticular and mucous texture is more or leſs ſoft, denſe, and thick, according to the parts to which it belongs; it has neither the ſame organization, nor the ſame extent, nor the ſame functions in the animals whoſe ſkin is covered with hairs, feathers, or ſcales. It is charged with a black matter in negroes; and when it has been deſtroyed by a wound or ulcer, this portion of the ſkin remains white in the cicatrix;

The epidermis is an almoſt inorganic membrane; it is compoſed of laminæ or plates diſpoſed in ſuch a manner that their edges cover each other like the ſcales of fiſhes. It is tranſparent, and very thin: it is re-produced very eaſily and very quickly; its place is ſupplied by real hard and horny ſcales in fiſhes, in ſerpents, and in the oviparous quadrupeds.

In general there exiſts no organic texture more varied and more different in itſelf than the whole of the integuments in the different orders or genera of animals. It would require a very extenſive anatomical diſſertation to point out only their principal differences, and theſe details would here be out of place. It may be ſufficient to remark that it is in the diverſity of the ſkin, and eſpecially in that of the extremities and appendages which cover, defend, or arm it, that the principal apparent difference of theſe beings conſiſts, and that this is conſtantly the indication or the ſeat of a more or leſs conſiderable difference in the primitive or interior organs of animals.

3. Inſtead of conſidering all the varied modifications of properties and of ſtructure of the different orders of animals,—modifications concerning which chemiſtry will at ſome future period have as many details and preciſe notions to give as the anatomical deſcriptions furniſh, and which will diffuſe over the arts and the employment of the tegumentous texture in general a light which would in vain be expected from any other ſcience; I ſhall occupy myſelf only with its general compoſition, which preſents more or leſs analogy in all animals. The ſkin of man, and of ſome of the mammalia, will more particularly ſerve me as example; and in treating of the character of ſome other ſkins, I ſhall only endeavour to ſeize their moſt remarkable relations. I ſhall examine more particularly the three different textures of the human ſkin, becauſe it is the moſt complicated in its organization; and I ſhall make it as it were the type to which I ſhall refer the properties of the other ſpecies of cutaneous textures of animals.

4. The derma, or the ſkin properly ſo called, when well ſeparated from the fat, the cellular laminæ, and the veſſels which adhere to it, as well as from the muſcular fibres with which it is provided in animals, is a thick, hard membrane, capable of being extended, elaſtic, difficult to be cut, preſenting fibres arranged or diſpoſed like the hairs of felt, leaving ſome areolar interſtices between them of a white colour. When it is briſkly heated, it contracts and is agitated; upon burning coals it melts, ſwells, exhales a fetid odour, and is reduced into a coal conſiderably difficult to be burned. It affords by the retort nearly the ſame principles as the fibrous matter, a thick oil, and much carbonate of ammonia. The products are in general very fetid; weak acids ſoften it, ſwell it, give it tranſparency and diſſolve it; the nitric acid diſengages from it much azotic gas and Pruſſic acid, and changes it into fat and oxalic acid: the concentrated cauſtic alkalies diſſolve it, and convert it into ammonia and oil. It is converted by its ſpontaneous decompoſition in water, and in moiſt and fat earth, into adipocirous matter and ammonia, as may be obſerved in burying places. The ſkins of the carcaſes that have been buried for ſeveral years, are found very diſtinct and ſeparate from the ſubjacent parts, preſenting a grey layer, conſiderably greaſy, brittle, and exhibiting all the characters of an ammoniacal ſoap.

5. The action of water upon the derma is the proceſs whereby its nature and compoſition are aſcertained in the moſt accurate manner. The derma, immerſed and kept in cold water, dilates, becomes ſlightly ſoftened, ſwells, loſes ſome of its tenacity, and at length becoming at the ſame time thicker, ſuffers the hairs which cover it to be pulled out with eaſe, after which it becomes ſemi-tranſparent, and ſeems to affect the gelatinous nature by this maceration. When the ſkin is left for a long time in this fluid, it becomes altered, putrefies, emits a ſtrong fetor, becomes like a ſoft jelly, and aſſumes an ammoniacal ſmell. If, inſtead of letting it putrefy in this manner, we boil in it a ſufficient quantity of water after it has been ſwelled, we ſee it melt, diſſolve entirely, and form a viſcid, gluey, thick, ropy, and even glairy liquor, which acquires a homogenous conſiſtence and liquidity when it is boiled for a ſufficient length of time. In this manner is formed a real animal mucilage, a jelly which becomes fixed or congealed by refrigeration, and which affords glue by evaporation and concentration. In many of the arts this property is well known and employed with much ſucceſs. Different glues are prepared with glove-ſkin, eel-ſkin, ſhreds of the ſkins of quadrupeds, of different fiſhes, &c. It is eaſy by this ſingle proceſs to find a remarkable difference between the different kinds of ſkins. That of

fiſhes melts quickly; that of man and of the mammalia, of the bullock and of the horſe, do not diſſolve, except with the addition of more water, heat, and time; but all of them, when ſubjected to a ſufficient maceration, at laſt melt in the water, and paſs to the ſtate of jelly or glue.

6. When we obſerve with great attention what happens in this tranſition of the dermoid texture into the ſtate of gelatin by ebullition in water, we remark that the ſkin of the bullock or of the horſe, which is very analogous in this reſpect to the human ſkin, preſents, previous to its melting, fibrous or filamentous flakes which ſwim in the liquor, and do not diſſolve without much difficulty, whilſt another portion has been diſſolved by the firſt impreſſion of the boiling water. Hence it has been concluded that the dermoid texture is compoſed of two principal matters, the gelatin and the fibrin. Citizen Seguin, who has much occupied himſelf with the analyſis of this texture, with a view towards determining the theory and perfecting the art of tanning ſkins, has formed more mature notions relative to its compoſition than chemiſtry before poſſeſſed reſpecting this object. According to him, the cutaneous fibre, being very analogous to the ſanguineous or muſcular fibrin, is only a kind of oxigenated gelatin, incapable of being combined in its fibrous ſtate with water and the tannin principle: it is neceſſary to unburn it as it were, or to deprive it of a

portion of its oxigen, in order to render it ſuſceptible of uniting with the tannin. It appears that a ſimilar diſoxigenation takes place in the long and ſucceſſive action of cold and of boiling water upon the derma, ſince from having been fibrous and inſoluble at firſt it at laſt becomes intirely ſoluble and gelatinous. The effect of the great and ſpeedy ſolubility of the ſkins of fiſhes and of oviparous quadrupeds, and the facility with which they form jelly, as well as the large quantity which they afford, is in favour of this idea of the oxigenated nature of the derma, ſince it appears to approach the nearer to the gelatinous ſtate as it belongs to animals that reſpire leſs, that require leſs atmoſpheric oxigen, and whoſe blood is the leaſt heated.

7. The obſervations and experiments which Citizen Seguin has made upon tanning, having led him to this theory of the nature of the texture of the ſkin, it is neceſſary to give the reſult of his experiments in this place. The precipitate of glue or of pure gelatin by tannin is brittle, and if the derma were purely gelatinous, tanned ſkins would be equally brittle. The fibrous texture of the derma does not combine with the tannin; but when we cauſe it to return to the gelatinous ſtate by taking oxigen from it we render it ſuſceptible of combining it with tannin. This is what is done in the preliminary clearing, ſoftening, and ſwelling of the ſkins before they are ſubjected to the tanning operation

tion. The fibrous part and texture of the derma being of an irritable nature, the action of the weak acids or alkalies cauſes the ſmall hollow filaments of theſe fibres to contract and thicken, till, by this action itſelf, this property is exhauſted by the effect of ſhortening, which diminiſhes the length, and increaſes the thickneſs of the derma. Its gelatinous part is dilated, divided, eaſy to be diſſolved and actually diſſolved in the water with which it is ſoaked; at the ſame time that its fibrin, dilated and ſhortened, is unburned by loſing a portion of its oxigen. In proportion as it is diſoxigenated, it combines with the tannin which is depoſited in it: it muſt not be too much unburned, nor return to the ſtate of pure gelatin; which would render it over-tanned and too brittle: it is on this account that in the ſwelling, the portion of gelatin which it contains is taken from it. The gallic acid which exiſts in the tanning water, already exhauſted of tannin by the ſkins, and which is diſcovered in it by its precipitating the ſulphate of iron in the black ſtate, particularly effects this decompoſition of the fibrous part of the ſkin, as we ſee it effect the diſoxigenation of ſilver, of gold, and of ſeveral other metals when we pour it into their ſolutions: it is on this account that the exhauſted tanning water is ſo uſeful for the ſwelling and unhairing of the ſkins. Finally, the fibrous derma, thus unburned, ſhortened, irritated and afterwards combined in a ſemi-gelatinous ſtate with tannin, having loſt its irritable property and primitive nature, can no longer be ſhortened nor change its dimenſions. However this tanned compound which in good leather is not real tanned gelatin, may ſtill be elongated and flattened, and preſerve a ſort of ductility under the hammer of the ſhoemaker who beats and works it; but it keeps, like the metals, the dimenſions which it has acquired by preſſure.

8. We may therefore draw the following inferences from theſe ingenious obſervations relative to the nature of the derma: that it is in general formed of two textures or two diſtinct matters; the one of which is gelatinous, immediately ſoluble in water and immediately precipitable by tannin: this is extracted from the ordinary ſkins of quadrupeds before they are tanned. The other matter, the true ſolid, extenſible, elaſtic, irritable texture of the ſkin of man, of the mammalia, and of the birds, is the fibrin or oxigenated gelatin; it contains the former in its meſhes; it contracts in one direction and ſwells in its length by the action of the ſaline ſtimuli; it is unburned by the acids, by long expoſure in water, and by ebullition; it returns to the gelatinous or ſemi-gelatinous ſtate according to the proportion of oxigen that is taken from it. It is undoubtedly in the proportion of theſe two matters that the difference of the two kinds of ſkins conſiſts, which is variable according to the nature of the animals, their manner of living, their very high or very low degree of oxigenation, &c.

9. The reticular texture of Malpighi, or the mucous net-work ſituated immediately upon the ſurface of the derma, and which contains the nervous papillæ deſtined for the perception of the touch, appears to be compoſed of two different ſubſtances ; a ſoft gelatinous covering extended over the whole ſurface of the ſkin and very light, and very fine granulated tubercles, which are nothing elſe than nervous expanſions. Chemical analyſis has not been able to operate upon this texture, as it is ſo fine and delicate, that it cannot be ſeparately detached, and ſeveral anatomiſts have denied its exiſtence, not having been able to diſcern it, even with the aid of ſtrong magnifying glaſſes and microſcopes. It is ſuppoſed that the black colour of the negroes has its ſeat in this texture, and that it depends upon a colouring matter diffuſed in it, becauſe this black ſubſtance may be removed by means of ſolvents without touching the derma and leaving it white, and becauſe the layers of the epidermis when ſkilfully ſeparated are tranſparent and colourleſs. Nothing has yet been done with reſpect to the colouring matter of the ſkin of negroes, neither do we know what is its nature ; we know however that it is capable of being diſcoloured and paſſing into a yellow tinge by the contact of the oxigenated muriatic acid. A negro who had placed his foot in a ley of oxigenated muriatic acid, and held it for ſome time in that liquid, preſented the part almoſt diſcoloured and inclining to whiteneſs ; but a black colour

as beautiful and as pure as that which it had before was entirely formed at the end of ſome days.

10. The ſcaly, dry and tranſparent texture of the epidermis in man proves by its mere aſpect, that it differs remarkably from that of the cutis: it is far from being ſo diſtinct in the animals. When the human ſkin is boiled in water, according to the obſervation of Citizen Chaptal, it firſt grows tough, and ſeparates into two diſtinct parts: the leather, or the cutis, which contracts, thickens and acquires the conſiſtence of a ſoftened cartilage; and the epidermis, which does not diſſolve, whereas a continued ebullition changes the cutis into a gelatinous mucilage. Alcohol does not attack the epidermis, even when kept for a long time in digeſtion upon this membrane. The cauſtic alkaline leys diſſolve it with eaſe. The ſame ſolution is obtained with lime water; but this ſolution does not take place unleſs during of a much longer ſpace of time than that which the pure alkali requires: this we perceive even in rubbing a cauſtic alkaline ley between the fingers; for it aſſumes an oily conſiſtence and feel, in proportion as the ley acts upon the epidermis which it diſſolves. Citizen Chaptal finds in thoſe properties an analogy between the external epidermis of the human body and the matter which covers ſilk. He obſerves that when a ſkin, provided with its epidermis, is immerſed into a ſolution of tannin,

the latter only penetrates it on the fleſh ſide, and that the epidermis, which does not combine with this ſubſtance, prevents its paſſing from the ſide of the hair or grain ſide. In the unfleſhing, the epidermis is removed from the ſkin, which then admits the tannin at both its ſurfaces; and the lime, which is generally employed in this operation, acts as a ſolvent of this exterior membrane. Lime-water, on account of the ſmall quantity of the earth which it contains, acts but very little, and requires to be renewed in order to ſeparate this external membrane.

Article X.

Of the Corneous Texture, of the Hairs, and of the Nails or Hoofs.

1. SCARCELY any part of the ſurface of the human body is entirely deſtitute of hairs; indeed they are well marked and in conſiderable quantites only in certain regions, eſpecially the axillæ, the pubes, the linea alba, the front of the breaſt, the region of the ſhoulder blades, the thighs and legs, the back of the hands, part of the face, of the chin, and the upper part of the neck. There are ſome individuals in whom almoſt the whole ſurface of the body is hairy, but theſe are in

general rare. The palm of the hands, the ſoles of the feet, the red part of the lips, the ſurface of the prepuce and of the glands, and in general all the parts that are covered with the *epithelium*, are the only part which are conſtantly deſtitute of hair. They are diſpoſed in a regular manner in ſome parts, curved into arches in the eye-brows, bent and projecting in the eye-laſhes, rigid and like ſmall pincers in the noſtrils, when they are called *vibices*; erect and in tufts in the concha of the ears, turned in different directions upon the chin, curled and ſhort upon the pubis, the axillæ, &c.

2. The ſkin of the cranium is provided with long hairs very cloſe to each other, deſtined to deſcend over the forehead, the ears, the back of the head and ſhoulders, when they are ſuffered to grow, conſtituting, like the beard, the natural ornament of man, and a defence againſt the rain, the heat of the ſun, inſects, falls and blows, cold, &c. The hairs of the head have not the ſame ſtructure as thoſe of the other parts of the body, though they are of the ſame nature. Much more tufted and ſtraight, they grow to a much more conſiderable length, and their growth has no real limits. Men differ very much from one another with reſpect to the nature of their hairs; and their races are characterized by hairs long and ſtraight, ſhort, curly or criſped, ſoft or rigid, long or ſhort.

3. The colour of the hairs alſo conſtitutes one of the moſt remarkable differences; it

varies in different countries, latitudes, climates, temperatures, ages, and ſexes. The human fœtus has them frequently white; they remain ſo in cold countries: however, in the moſt rigorous climates and towards the poles they are brown. In the fiftieth degree of latitude, according to Haller, red hair was formerly the moſt frequent. The hotter the climates are, the more the hair approaches to the black. An exception to this rule are the Albinos, ſo called on account of their pale-blue ſkin and their milk-white hair. It is generally ſaid, that cold and phlegmatic temperaments that abound in white juices are characterized by very fair hair; that the choleric temperament produces red hair, and the ſanguine black. Whatever be the climate, the hairs conſtantly turn white in old men, and become tranſparent by the dryneſs of their centre. It is alſo commonly ſaid that grief turns the hair white, though moſt phyſiologiſts deny the certainty of this fact. Some diſeaſes produce this effect. In ſeveral animals, eſpecially hares and rabbits, the hair becomes white in the winter, particularly towards their points. The diameter of the hairs of the head has been eſtimated at between $\frac{1}{300}$ and $\frac{1}{700}$ of an inch. Withof counted 572 black hairs in the ſpace of an inch, 608 brown, and 790 fair; ſo that the latter are reckoned to be the thinneſt.

4. The hairs have a very remarkable ſtructure, which has been very well deſcribed by

ſeveral anatomiſts, eſpecially Malpighi, Ledermuller, Withof, Chirac, and Haller. Under the cutis, and in the midſt of the fat which diſtends the cellular texture, are implanted in this cutaneous fat which appears to be their true ſeat, oval, flat, reddiſh bulbs, formed of a hard, elaſtic, exterior tunic, and ſupplied by ſanguineous veſſels. The interior of this external integument, which is hard and eaſy to be cut into ſmall laminæ, and from which a more or leſs viſcous ſanguineous liquid flows when it is open or punctured, contains a ſmaller bulb, cylindrical, oblong, hard and white. The baſe of the hair is incloſed in this interior bulb; the hair in it is finer, and ſofter than in its exterior part, crooked and conical. It iſſues from the tube covered with two integuments furniſhed by the membrane of both bulbs. When it has arrived at the pore of the ſkin through which it paſſes, it relinquiſhes its exterior covering, and retains only the interior. In paſſing immediately under the epidermis, it raiſes and puſhes before it this membrane, which ſurrounds it, and thus furniſhes it with a ſecond exterior covering. This ſecond tunic adheres ſtrongly to the proper tunic which the hair receives from the interior bulb: it is tranſparent, hard, and corneous. When we cut this epidermoid tunic, we find the interior texture of the hair compoſed of from five to ten filaments connected together by a mucous and gluey texture; this interior and central texture of the hair is thick as in the bulb itſelf: it ſhrinks and diſappears by drying.

5. To this ſtructure deſcribed by the anatomiſts, and eſpecially by the illuſtrious Haller, I ſhall add that the exterior covering appears frequently to form ſcales detached from the ſurface of the hair, towards the upper part of each, like ſmall branches diverging from it, and that it is on this account that when we rub a hair between two fingers, it always raiſes itſelf, like the beard of corn, in the direction from its baſe towards its point: ſo that when we paſs this delicate organ between the fingers with a rotatory motion, we may eaſily diſtinguiſh its baſe from its point by the circumſtance that it always moves in the direction of the latter; that is to ſay, it aſcends if the point be placed downwards, and deſcends if it be placed uppermoſt. It is by this ſtructure, which anſwers inſtead of ramifications, and acts as it had very ſhort branches, that Citizen Monge has explained the effect of felting which hairs experience by the mere friction or percuſſion which is applied to them: theſe ſmall filaments become engaged in their reciprocal notches, and are thus ſolidly hooked together by preſſing them cloſe againſt each other. It is alſo evident, according to the ſtructure that has been indicated, that the hairs, viewed by the microſcope, muſt appear like kinds of ſticks tranſparent and ſolid, like ſcales or horn; that when we cut them, and view their horizontal

ſection, or the perpendicular with their axis, they muſt exhibit a kind of marrow at their centre; that this central medullary texture, proceeding from the interior bulb, muſt, by drying, leave the membranes alone, tranſparent and dry, and give whiteneſs to the hairs; that when they begin to dry they muſt ſplit at their extremities, and that it is on this account that we frequently find them bifurcated. It is alſo evident, that on account of their double covering, and of the medullary and filamentous centre which they contain, the hairs muſt poſſeſs a certain ſtrength, and ſupport ſome weight without breaking.

6. We may alſo conſider the hairs as hollow tubes, or ducts, communicating immediately with the cellular texture, capable of pouring into the atmoſphere a vaporous liquid, or one ſuſceptible of diſſolving in it, and conſtituting a particular emunctory. They are capable of impeding the electric fluid, and of inſulating thoſe bodies which they cover, as ſilk does. They poſſeſs, like many animal textures, the hygrometric property in ſo marked a degree, that they are employed for conſtructing hygrometers in preference to all others. It is on this account that the hair ſo readily loſes its curl by the contact of water, of dew, or of fogs. The hairs dry and fall off in diſeaſes; their bulbs are frequently deſtroyed by depraved ſtates, or ulcerations of the cellular texture. They ſwell and become painful, though inſenſible in their pro-

per texture, by the effect of the *plica polonica*. Their diameters, being augmented in this affection, permits the blood to flow out by their extremities; and it is upon this principle that we are to account for the drops of blood, or the hæmorrhages, which follow the cutting off the hair in this terrible malady. Finally, the hairs receive ſuch an influence from external bodies, that the perſons who work copper have them coloured green by the oxide of this metal, even in their interior part, and not merely in their external layers.

7. After having deſcribed the ſtructure and the phyſical properties of the hairs, we muſt occupy ourſelves with the examination of their chemical properties. Formerly the analyſis of theſe bodies was attempted by the action of fire: Neuman having treated a pound of hair in the retort, obtained from it five ounces and ſix drachms of urinous ſpirit, two ounces and one drachm of concrete volatile ſalt, three ounces and ſix drachms of oil, four ounces and three drachms of caput mortuum, containing twenty one grains of ſalt. But notwithſtanding this kind of repartition of the products of ſix ounces of diſtilled hairs by Neuman, it is evident that his analyſis was far from being exact, as he intirely neglected the elaſtic fluids which are diſengaged in abundance from diſtilled hairs, and of which he had taken no account; and as he found again the total

weight, it cannot be doubted that he was obliged to ſuppoſe the quantity of ſome of the liquid products, which he alone collected, to be more conſiderable. We ſhall ſee, by the expoſition of a more recent analyſis, that there are ſtill other errors in that of Neuman.

8. It is to Citizen Berthollet that we owe this ſecond analyſis, which is much more exact than that of Neuman, though the French chemiſt publiſhed it in 1776, in his *Obſervations upon the Air*, at a period when the analytical proceſſes were infinitely leſs advanced and perfected than they are at preſent. Two ounces of hair afforded Citizen Berthollet one drachm and eighteen grains, or nearly a thirteenth of their weight of ammoniacal carbonate; two drachms and a half, or more than a ſixth of their weight of water, having a very ſtrong ſmell of burned hair, and ammoniacal from the commencement of the diſtillation; four drachms, or a fourth of their weight of an oil, very different from that which is obtained from the other animal ſubſtances: and laſtly, there remained four drachms and a half, or more than a fourth of their weight, of a coal, the particles of which were very ſenſibly attracted by the magnet, and which he was not able to calcine. This chemiſt, is eſtimating at a drachm and a quarter the portion of water, of oil, and of ammoniacal carbonate loſt, ſtates at two drachms and eighteen grains the elaſtic fluids diſengaged,

gaged, the nature of which he has not indicated, and which are manifeſtly carbonated hidrogen gas, mixed with carbonic acid.

9. In the account of this analyſis, he inſiſts particularly upon the oil afforded by the hairs, on account of its large quantity, as well as of its very remarkable properties, and its difference from all the other oils obtained from different animal ſubſtances. This oil was yellow at firſt, and became black only at the end of the diſtillation. It did not alter the colour of the ammoniacal carbonate; it was very ſoluble in alcohol; it burned with the ſcintillation and vivacity which every one remarks in the intire hairs when burning; it remained in a concrete form till the eighteenth degree of Reaumur's thermometer: its weight was not much different from that of the water charged with ammoniacal carbonate obtained in this analyſis; ſo that when fluid it ſwam at the top, and when concrete it ſunk to the bottom of this liquid. He concludes from theſe obſervations, that the hairs are principally compoſed of oil; but this concluſion, which might be admitted ſtill in 1776, but which can no longer be conſidered as exact, muſt now be conſidered only as a ſimple proof of the great diſpoſition which the hairs have to aſſume the oily character, as is proved in fact by their violent inflammation, their fuſibility, their fatty nature, and the impracticability, not only of diſſolving them in water, but even of wetting them. It

is alſo to be obſerved that this opinion of the learned French Chemiſts accords with that of Haller, who, in his great phyſiological work, remarks a ſingular analogy between the hairs and the fat, the conſtant ſituation of the former in the latter, and the frequent circumſtances of morbid fatty concretions, or ſteatomes filled with hairs.

10. The quantity of carbonate of ammonia afforded by the hairs appeared ſo conſiderable to Haller, and ſtruck his attention ſo forcibly, that he was aſtoniſhed that J. Godard, who deſcribed the ſecret of the preparation of the Engliſh drops bought by Charles II. King of England, employed ſilk and not hair, which, he ſays, would have more eaſily afforded him an abundant quantity of this ſalt. This ſame abundance led Citizen Berthollet to doubt in 1760, whether the volatile alkali did not exiſt ready formed in the hairs; and it is certain that no animal ſubſtance affords it ſo abundantly or ſo quickly. It is likewiſe very remarkable that its coal is ſo difficult to be burned, and that it contains a very ſenſible quantity of iron attractable by the magnet. We ſhould be tempted to believe, according to this fact, that the hairs contain in their interior the colouring part of the blood, and that their coal, like that of this colouring part, contains phoſphate of iron. This coal is hard and brilliant, adheres ſtrongly to the glaſs, and reſembles carbonate of iron: there is reaſon to believe that this coal is

alſo charged with phoſphate of lime; for Citizen Vauquelin and myſelf have found this ſalt in the hairs of the horſe and in the claws of ſeveral animals; and theſe parts have the moſt perfect analogy in their nature and compoſition with the human hairs. There is alſo a little carbonate of lime in the aſhes of hair; black hair even appears to afford more of it than fair.

11. The hairs are thoſe parts of the human body that endure the longeſt; they do not contain the ſame principle of decompoſition and of change of nature which exiſts in moſt of the other animal ſubſtances; they are more durable even than the bones; and in ancient ſepulchres in which the ſkeletons were reduced to powder, or intirely deſtroyed by the action of water and air, the hairs ſtill ſubſiſt, after having reſiſted the efforts of ages, and atteſt that human bodies had been depoſited in them. It is very eaſy to conceive that this preſervation depends intirely upon the corneous inſoluble nature of the hair, and that not being alterable either by air or water, which gradually melt and attenuate all the other animal ſubſtances, they retain their properties and their compoſition even in the midſt of the deſtruction which ſeizes upon all the organic parts. Garman in his Treatiſe *De miraculis mortuorum*, adduces a great number of facts and obſervations which prove this indeſtructibility and inalterability of the hairs.

12. Though ſo little alterable, the hairs are however not exempt from the impreſſion of ſeveral re-agents which more or leſs change their nature. Strong ebullition in water, frequently employed in the arts in which theſe bodies are worked, cauſes them to undergo a ſoftening and partial fuſion, the firſt ſigns of which are peceived in the hygrometrical action which cold water exerciſes upon them. Some perſons even pretend that when they are boiled for a very long time, they become intirely melted in the water and form a jelly; others aſſure us that it is only a portion of the covering of the hair, and not its proper interior ſubſtance, which diſſolves in the water, and affords the gelatin which is obtained from it. No chemiſt has hitherto examined this action with ſufficient attention. The decoction of hair is always coloured.

13. The acids alſo ſoften the hairs and diſcolours them: the muriatic acid whitens them at firſt, but they become yellow by drying; the nitric acid gives them a golden colour. The alkalis diſſolve them very well and reduce them to the ſtate of a kind of reddiſh liquid ſoap, diſengaging from them ammonia and approaching them to the oily ſtate. The metallic oxides in general burn, and conſequently blacken the hairs: they are frequently employed for colouring them upon the head. Thus when they are rubbed or impregnated with fat charged with red oxide of lead and lime, they become black

at the end of ſome days. There are alſo employed for this purpoſe acetite of lead, ſometimes even nitrate of lead, or the nitrates of mercury and of ſilver. After the uſe of theſe metallic ſolutions, the hairs are rubbed with oil, and become ſtill blacker by its contact. In all theſe phenomena hair greatly reſembles ſilk, more eſpecially the horns of the mammalia, the ſhell of the tortoiſe, &c. Thoſe properties which have been deſcribed relative to the epidermis alſo exhibit a great analogy with the texture of the hairs.

14. The nails, which anatomiſts juſtly conſider as a prolongation of the epidermis, and like this laſt, cover a mucoſo-nervous and papillary texture, grow, lengthen, and are renewed without limitation, as is exemplified upon the fingers of the Faquirs of Malabar. Duverny has compared them with horn, and Ludwig with hair, and in fact they are of a very ſimilar nature or compoſition. They ſoften by long maceration and decoction in water; this decoction is rendered but very little turbid by tannin,—ſtill leſs than that of the hair; they cannot be completely diſſolved. They diſſolve in the acids, are melted in the alkalies, are coloured and burned in the metallic ſolutions, and they adhere to colouring matters and are ſolidly dyed, as we may ſee by inſpecting the hands of dyers.

15. It may be concluded from all theſe facts, that the corneous animal texture and eſpecially the matter of the epidermis, of the

hairs and of the nails is an oxigenated gelatinous ſubſtance, little or not at all ſoluble, rendered ſolid, elaſtic, unalterable and very durable in its intimate nature, not only by its ſtate of oxigenation, but alſo by its union with a conſiderable quantity of phoſphate of lime, and even with a ſmall quantity of carbonate of lime; ſo that theſe concreſcible and little ſoluble ſalts, being depoſited with an oxigenated gelatinous matter exiſt as it were in the ſtate of a tanned ſubſtance. Every fact announces that theſe corneous textures, ſo abundant upon the ſurface of the body of man and of animals, are reſervoirs into which the exceſs of the nutritive matter and of phoſphate of lime is depoſited. The firſt is depoſited in them eſpecially at that period of their life when their growth has ceaſed; the ſecond is collected in them, eſpecially in thoſe animals from which the urine does not carry off this matter of the bones, as I ſhall ſhow in ſpeaking of the urinary liquids and of the oſſeous texture: accordingly, the mammalia of which I ſpeak, have their ſkin intirely covered with hair; whilſt man, whoſe ſkin is almoſt bare, evacuates by urine the exceſs or too great abundance of oſſeous matter.

ARTICLE

ARTICLE XI.

Of the Cartilaginous Texture.

1. THE cartilaginous texture has a conſiſtence and ſtructure which ſufficiently diſtinguiſh it from all others; it is an almoſt ſolid body, white, of a milky tranſparence, conſiderably reſembling to the colour of the chalcedony or the opal, ſuſceptible of compreſſion, highly elaſtic, eaſy to be cut, ſmooth and poliſhed in its ſection, like a reſinous matter, granulated or like ſhagreen in its fracture. It has not the hardneſs of the corneous texture, but is intermediate between this ſubſtance and the ligament. The cartilages are moſt frequently ſituated at the articular extremities of the bones which they cover, and into the texture of which they enter, or between bones which they keep aſunder and ſoften their friction, whether they be moveable or fixed. Sometimes they conſtitute particular kinds of organs, as in the human larynx.

2. The ſtructure of the cartilaginous texture is difficult to be determined and deſcribed, and Haller acknowledged that it was much more obſcure than that of the bones. It is not diſtinguiſhed from the latter in the fœtus. Its difference from the oſſeous texture is very ſlight

in thoſe of the larynx and of the ribs; it is ſeldom or never converted into oſſeous texture in the two parts of the larynx and the ribs. In ſome cartilages we ſee, in the interior, a ſort of core, or granulated texture, covered with a whiter and finer matter: it is very difficult to diſcern laminæ or fibres in this part. The tendons that undergo a ſtrong preſſure, become converted into cartilages, like that of the peronæus longus in its paſſage under the cubiform bone: the thyroid gland, the tunics of the large arteries, the ſides of cyſts and of aneuriſms frequently become cartilaginous. The firſt rudiments of the bones in the human body are real cartilages; in the adult, and by the progreſs of oſſification, they have only a ſlight cartilaginous cruſt at their extremity. The articular and inter-articular cartilages never become oſſified, on account of their continual humectation. The intervertebral cartilages formed into ligamentous rings at their extremity, and into a glutinous, thick, white humour, ſimilar to a flakey ſtarch, at their centre, become oſſified but very rarely.

3. Some familiar and domeſtic facts are well adapted for affording a notion of the chemical nature of cartilage. It is known that this animal matter ſoftens in water; that, by its ſoftening, the laminæ, or the fibres which enter into its ſtructure, become perceptible by ſwelling, ſplitting, detaching themſelves from the oſſeous ſurface in their divided part; that they aſſume

the gelatinous nature by long ebullition, and the tranſparency which characterizes this ſubſtance. Theſe phenomena preſent themſelves at the extremities of the bones which accompany the meat which we boil, and many perſons prefer theſe cartilaginous parts when ſoftened and converted into jelly by boiling. Hunter, one of the anatomiſts who have occupied themſelves the moſt with the nature of cartilage compared with ſeveral other animal parts, has collected ſeveral experiments by which he has endeavoured to prove the difference of its texture from that of the bones. According to his experiments, the cartilages are not ſoftened in the acids; they diſſolve completely in hot water. They are not coloured like the bones, or along with them by madder mixed with the food of animals.

4. To theſe characteriſtic properties it is added, that the cartilages do not exfoliate in diſeaſes; that they do not ſoften like the bones; that they are not re-produced after having been deſtroyed. Theſe comparative obſervations we owe to Hunter. Haller concludes, from a compariſon of theſe facts, that cartilage is formed of thickened gluten, into which it may be converted by art; that this gluten receives, as it becomes concrete, a ſlight portion of calcareous matter, or of phoſphate of lime, which renders it ſolid; that it is on this account that cartilaginous texture is formed in the ſides of the arteries, in the membranes of the ſpleen, in

the thick part of the pleura, of the pericardium into which a glutinous humour is poured; that their oſſification, which takes place in ſome caſes, or with very old ſubjects, depends upon a too great quantity of calcareous matter, which is precipitated and collected in their aſcular texture, as well on account of its known ſuperabundance in old perſons, as by the dilatation of the veſſels which convey the nutritive juice. This great anatomiſt concludes from the analogy of the cartilage with the bones, that there muſt exiſt in the one as well as in the other, fibres and laminæ, but that they are concealed by the opaque and homogeneous gluten, which covers them on all ſides.

5. While borrowing theſe general conſiderations from the immortal work of the Helvetian phyſiologiſt, I have endeavoured to ſupply the ſilence of the chemiſts reſpecting the nature of the cartilages: I do not know of any particular analyſis having been made of them. If what Haller advances were perfectly exact, it would follow that the cartilages are of a compoſition ſimilar to that of the corneous texture; but this analogy, at leaſt if taken in all the latitude in which it is here preſented, is not probable, becauſe the mere aſpect of the cartilaginous texture, its living properties, and its morbid alterations, prove that there exiſts a very remarkable difference between the two textures. We muſt indeed admit the preſence of the phoſphate of

lime in cartilage, as well as in the corneous texture; but it appears, that beſides a remarkable difference in the proportion, the gelatinous matter of the firſt differs from that of the ſecond by a modification, which chemiſtry is alone able to determine, and may throw much light upon the very imperfect knowledge we yet poſſeſs of the intimate nature of cartilage.

Article XII.

Of the Oſſeous Texture.

1. THE ſyſtem, or the totality of the bones, which ſupport the whole animal machine, and give its general figure, its ſize and its firmneſs, forms the laſt ſolid texture which remains to be examined; for the bones are the laſt parts which we find in the order of diſſection; thoſe which conſtitute the laſt term of nutrition, and into the nature of which ſeveral of the preceding textures paſs. There exiſts in the animal economy a power which tends to produce the oſſeous matter, and to depoſit it in moſt of the other organs. Accordingly, the natural termination of life in animals ſeems to depend upon this oſſification which predominates over the other functions, and oppoſes their exerciſe. The bones conſtitute one of the parts

the moſt generally diffuſed throughout the whole continuity of the animal body, for here is no region of which the baſe is not a ſolid or oſſeous organ. They muſt, therefore, be reckoned amongſt textures belonging to the whole animal economy, and performing one of the principal functions of life which ſupport its exiſtence.

2. All the bones being connected together by ligamentous fibres, united and articulated, form a ſyſtem ſubdivided and moveable in a great number of points; without being removed or ſeparated in the healthy ſtate; they conſtitute all together what is called the ſkeleton. Their ſolidity, their white colour, their elaſticity, and their denſity, diſtinguiſh them ſufficiently from all the other organs. In order to characterize them, they are diſtinguiſhed, amongſt the numerous bones which form the ſkeleton, into the flat, the long, the cylindrical, the cubical, &c. We obſerve in them poliſhed ſurfaces, cavities, eminences, or apophyſes, depreſſions, impreſſions, aſperities, grooves, ſinuoſities, canals, which, whilſt they characterize each in particular, remind us, by their mere aſpect, of their relations, and contiguities with many other parts, with the uſes for which they are deſtined. Their extremities generally preſent projecting or excavated ſurfaces, fittings, heads, cavities, condyles, pullies, either naked or more frequently covered with cartilages deſtined for uniting them cloſely with the con-

tiguous bones, or permitting them to move, to ſlide upon each other, and to change their reſpective ſituation more or leſs conſiderably. In young animals, the bones are more numerous, many of them being ſeparated into ſeveral others, and preſent detached or diſtinct parts, which are called *epiphyſes*. Theſe ſeparated parts diſappear with advancing age, and the bones even adhere at ſeveral points to one another, ſo that in old age the ſkeleton tends to form only a ſingle piece. All the bones are covered with a membrane which adheres very ſtrongly to them, in ſeveral very diſtinct laminæ, and is called the perioſteum. Anatomy occupies itſelf with this external ſtructure, with the deſcription of the bones one after the other, in ſo accurate and detailed a manner, that great part of the works upon this ſcience is conſecrated to it, beauſe it is conſidered as the baſe of all the other parts of anatomical knowledge. The inſtructed eye, on ſurveying the ſkeleton, ſoon applies to it all the other parts, ſo that it becomes the type upon which memory raiſes, as nature herſelf ſeems to have done, the whole edifice of the animal body.

3. The internal ſtructure of the bones is no leſs important to be known than their ſurface and their figure, eſpecially in order to arrive at the determination of their intimate nature or compoſition. Theſe ſolid organs appear, when broken, to be formed of laminæ applied

to each other, ſometimes very cloſe and compact, as in the centre of the long bones, ſometimes ſeparate, and leaving between them porous cavities, preſenting ſmall veſicles, like thoſe of a ſponge: accordingly, this latter texture is called ſpongy or cellular. The flat bones are, in general, formed of two tables, having a ſpace between them, and ſupported by ſome ſolid fibres paſſing out of one table into the other; the intervening ſpace is filled with a reddiſh ſoft texture, which is called *diploe.* In the long bones, there is a medullary cavity or canal, full of a kind of fat called *marrow,* which is depoſited in a cellular membrane detached from the interior perioſteum, and itſelf ſupported upon ſome oſſeous laminæ, or ſome filaments detached from the internal ſurface of theſe bones; blood-veſſels which perforate the body of the bone obliquely arrive at this internal perioſteum, and pour into it the liquid which nouriſhes them. The middle part of the long bones is compoſed of very cloſe laminæ, forming a conſiderable thickneſs: towards the extremities theſe laminæ diverge from one another, ſeparate, and form by their ſeparation oſſeous cells, which conſtitute the whole thickneſs and the whole ſtrength of the heads of the bones; ſo that theſe dilated extreme parts, which are very thin in their external oſſeous layer, nevertheleſs reſiſt a great degree of preſſure by the conſiderable number of plates and of ſolid columns which bear upon the internal ſurface of the layer. The cellular texture of theſe dilated extreme parts, or of theſe heads, of theſe condyles of the long bones, is filled with a juice analogous to the diploe which is found between the tables of the flat bones. However cloſe the laminæ of the bones may be in their ſolid part, they nevertheleſs eaſily ſuffer a part of the medullary oil placed in their interior cavities to inſinuate itſelf between them. The bones have an elaſtic texture ſuſceptible of a certain degree of extenſion, of a certain elongation before it breaks.

4. The external and internal ſtructure of the bones has been known much earlier than their intimate nature or compoſition. Exact and even minute deſcriptions of their ſurfaces, their ſlighteſt inequalities, of all their parts, were already completed; the great works of Veſalius, of Columbus, of Riolanus, of Clopthon-Havers, of Albinus, of Monro, of Bertin, and of many other celebrated anatomiſts, had brought this deſcriptive part to its perfection; many curious reſearches had even been made upon oſteogeny or the formation of the bones; and the valuable diſcoveries of Kerkringius, of Duhamel, of Fougeroux, of Haller, of Troja, &c. had already thrown ſome light upon this beautiful part of phyſiology, before chemiſts had diſcovered the real nature of theſe organs. Till 1774, we contented ourſelves with diſtilling the bones, determining their products in an

inaccurate manner, looſely ranking their baſe amongſt the earths, though it had been ſuſpected that it had conſtituted a particular earth. Papin, Heriſſant, Laſſone, Haller, had carefully diſtinguiſhed and proved by experiments that the bones were formed of two different ſubſtances; the one glutinous, ſuſceptible of diſſolving in boiling water, and forming a jelly which was prepared for the uſes of ſeveral of the arts; and another ſubſtance which had been conſidered as calcareous or abſorbent; when one of thoſe capital diſcoveries, which tend to change the aſpect of the ſcience, was made by two Swediſh chemiſts. Gahn and Scheele proved, by exact experiments, that the pretended oſſeous earth was an earthy ſalt compoſed of phoſphoric acid and lime, which could not conſequently be converted into lime by the action of fire, nor ſaturate the acids after the manner of an ordinary abſorbent earth. This diſcovery was ſoon confirmed by a great number of chemiſts, eſpecially in France, where the proceſs of the decompoſition of the bones, as well as the art of extracting the phoſphorus, was ſimplified by Rouelle the younger, Macquer, Poulletier de la Salle, Nicolas de Nancy, and Berniard. It will ſoon be ſeen that by a late courſe of inquiries made by Citizen Vauquelin and myſelf in conjunction, we have added a new degree of preciſion to the analyſis of the calcareous phoſphate of the bones.

5. The bones expoſed to fire in contact with the air, if we begin by a mild temperature, firſt dry and become brittle; then a fatty oil eſcapes from their interior and turns their external layers yellow. To the aqueous vapour which is firſt exhaled, ſucceeds, when the action of the fire is augmented, a fetid and greaſy ſmell; the ſurface of the bone becomes brown, a thick white vapour is diſengaged from it; it then takes fire, and continues to burn till the whole of its oil is diſſipated. The bones are then black and in the ſtate of coal when they are ſuffered to cool; but when they are heated to redneſs, their coally matter burns from the ſurface to their internal part, and they are at laſt changed into a white friable ſubſtance, inſoluble in water: ſuch are the calcined bones which are uſed in the arts for rubbing and poliſhing diamonds, and forming cupels. Theſe calcined bones, lixiviated in water and by the acids, afford a little carbonate of ſoda, carbonate of lime, and a large quantity of calcareous phoſphate. The proportion of this ſaline earthy ſubſtance, with reſpect to the whole bone, is 0,65 as the average term of many varieties with reſpect to the age, the ſtate of this organ, its ſolidity, &c. If we heat the calcined bones to an intenſe redneſs, they experience, at the ſame time emitting a yellowiſh phoſphoric light with which they ſeem to be penetrated, a ſemi-fuſion which aſſimilates them to the ſtate of porcelain. They have a fine

cloſe ſemi-vitreous grain, a great degree of denſity, a ſemi-tranſparency, and that ſoft aſpect which belongs to all the vitrified earths.

6. When we treat the bones in cloſe apparatuſes, diſtil them in a retort, from the mildeſt temperature which is uſually employed in theſe operations to the moſt intenſe heat which theſe veſſels can ſupport, we obtain water which gradually aſſumes the oily ammoniacal colour and ſmell, oil partly liquid and light, partly heavy and concrete, of a brown-red colour, very fetid; carbonate of ammonia diſſolved in water and in a concrete form, ſoiled by a portion of oil, a carbonated and ſulphurated hidrogen gas, and carbonic acid gas. There remains in the retort a coal which retains the form of the bone that has been put into the veſſel. When we carefully examine the water which is obtained in conſiderable abundance in this diſtillation, we find in it, beſides the ammoniacal carbonate, a ſmall quantity of ſebacic and of Pruſſic acid combined with ammonia: the thick oil, ſeparated from the other products and ſubjected to rectification, becomes in part liquid, volatile, of an almoſt aromatic ſmell, and in every reſpect ſimilar to what is called *Dippel's animal oil;* it is always a little ammoniacal, and turns the ſyrup of violets green. The coal calcined in open veſſels heated to whiteneſs, affords the ſame reſults as thoſe which have been enunciated in Article 5. Formerly the products of the diſtillation of the bones were

employed in medicine, and thoſe obtained from the human cranium, or from the horns of deer, were preferred. It is very evident that theſe products of the combuſtion and of the diſtillation of the waters, with the vapours, the inflammation, and the liquid and gaſeous products, are owing to the gelatinous or truly animal portion of theſe parts; for the earthy ſalts can neither be their cauſe or their ſource.

7. Bones expoſed to the air gradually become dry, brittle and arid; they become white when they are long expoſed to the dew; and afterwards turn yellow, eſpecially by age and during hot ſeaſons; whilſt they thus acquire colour, they become greaſy and oily at their ſurface. After a great length of time having been turned brown by a kind of ſlow combuſtion, they decay, ſeparate into ſmall ſcales, and fall into powder. It is in this manner that they are gradually deſtroyed in the fields and in burying places; but ages are ſcarcely ſufficient to effect this deſtruction. I have examined ſome that had remained nearly three hundred years in a charnel-houſe, defended indeed againſt the rain, which were ſtill very hard and elaſtic, and contained their gelatinous part almoſt entire. Van Swieten mentions a ſkeleton kept in his muſeum, the bones of which were ſpontaneouſly deſtroyed, and fell into powder by the effect of a virus which, according to him, ſtill exiſted in this ſubject, and re-acted upon the texture and the compoſition of its

bones. It is known that theſe organs receive, and eaſily promote the germination of ſmall ſeeds of vegetables which cover their ſurface with a greeniſh moſs; that when buried in the ground, they admit carbonate of lime into their pores, which the water depoſits between their layers, at the ſame time depriving them of a part of their gelatin; that they are ſometimes incruſted with it, and improperly take the name of *petrified bones;* and laſtly, that when penetrated by a ſolution of oxide of copper, they acquire a green colour, and are called *turquoiſes.*

8. The action of water upon bones is one of the phenomena which has been the longeſt known, and which has been employed with the greateſt ſucceſs for determining their nature. Cold water acts but very ſlowly upon theſe organs; when they remain in it for ſome days, it gradually penetrates their pores, divides and ſeparates their laminæ, and ſoftens their gelatinous parenchyma: their medullary juice is eaſily converted into adipocirous matter. Boiling water attacks their texture, when they have previouſly been reduced into ſmall fragments, into chips, into powder, or into thin laminæ; it diſſolves their white cartilaginous matter, and quickly changes it into very pure gelatin: theſe bodies are in preference uſed for preparing the whiteſt, the moſt tranſparent, and the mildeſt jelly, which is the moſt ſuſceptible of receiving all the moſt varied taſtes, perfumes, or ſeaſonings. Thus a light and

agreeable aliment is extracted from hartſhorn. Thus ivory and bones afford a nutriment uſeful in certain circumſtances. The gelatinous ſubſtance of the bones is ſoftened in theſe organs in their entire ſtate, when they are ſubjected to water raiſed to a temperature much ſuperior to that of its ordinary ebullition, as takes place by the ſtrong compreſſion in Papin's machine or digeſter, in which the moſt ſolid bones are ſoftened in a few minutes. Theſe bodies, thus deprived by the water of their gelatinous ſubſtance, become afterwards, when ſlowly heated, dry, brittle, and friable; and their laminæ ſeparate eaſily from one another. I ſpeak here only of the action of water upon the oſſeous laminæ when pure and ſeparated from all that does not belong to them. The proportion of this gelatin, *extracted* from bones by means of water, appears to be from 0,25 to 0,35. If we heat entire and freſh bones in this liquid, their perioſteum, as well as the tendons and ligaments which remain attached to it, are diſſolved and increaſe the proportion of gelatin; their marrow melts and collects at the ſurface in the form of oil. This is the reaſon why they contribute to the mild and unctuous alimentary quality of broth. The ſtomach and the digeſtive power effect the decompoſition of bones ſtill better than hot water, and thoſe animals which take them as food, diſcharge them in a great meaſure deprived of their gelatinous matter, as is proved by the chemical analyſis of the excrements of dogs that eat bones, excrements formerly called in the materia medica by the ridiculous name of *album græcum.*

9. It has long been known that the weakeſt acids have the power of ſoftening bones, and of diſſolving that part of them which was called *earthy.* Heriſſant, in examining this phenomenon with ſome attention in a Memoir inſerted amongſt thoſe of the Academy of Sciences of Paris, for 1758, thought he had found in the nitric acid (with which he ſoftened the bones which he ſoaked in it, by diſſolving their earth, which he believed to be cretaceous, without affecting their membraneous cellular part) a means of inſulating the two conſtituent matters of theſe organs. Haller has verified this ſoftening of the bones even by the acetous acid and lemon juice: he ſuſpected that in the ſoftening of the bones by the effect of diſeaſes, there exiſted an acid which thus corroded them. All the chemiſts have afterwards obſerved that a ſolution of bones in an acid precipitated by alkali affords a ſeemingly earthy matter, which does not poſſeſs the property of becoming quick-lime by calcination. It is to Scheele that we are indebted for the true knowledge of this phenomenon. After having, like Heriſſant, diſſolved bones in the nitric acid, he filtrated the liquor, and aſcertained that, though always acid, even when ſaturated with all that it could diſſolve of bone, it precipitated

ſulphate of lime by the addition of concentrated ſulphuric acid; and that after this precipitation, the ſolution drawn off clear, and evaporated in a retort, afforded volatilized nitric acid, and left phoſphoric acid, which was fuſed into glaſs by the action of a ſufficient heat. He concluded from this experiment that the nitric acid diſſolved the phoſphate of lime, the baſe of the bones; that the ſolution in this acid was a mixture of calcareous nitrate and of phoſphoric acid; that when the firſt was decompoſed by the ſulphuric acid, and the precipitated ſulphate of lime ſeparated from it, there remained only a mixture of the two acids, the phoſphoric and the nitric, and that this latter mixture, when heated, diſengaged volatile nitric acid, whilſt the fixed phoſphoric acid remained at the bottom of the retort. We ſhall ſoon ſee that things do not happen exactly in this manner: but before we prove this, it is neceſſary that we ſhould give an account of what chemiſts have done reſpecting this action of the acids, between the epocha of the diſcovery of Scheele, and that of our own inquiry, the laſt that has been made to my knowledge upon this kind of analyſis.

10. Poulletier de la Salle and Macquer firſt repeated, at Paris, Scheele's analyſis of the calcined bones, and found it accurate with reſpect to the preſence of the phoſphoric acid in the bones, and the art of extracting phoſphorus from them. Rouelle the younger, when he

alſo occupied himſelf with this ſubject, obſerved ſeveral important facts, and deſcribed them with much accuracy in the Journal de Medicine of the month of October, 1777. Such are, amongſt others, 1. the means of ſeparating carefully, by repeated decantations and filtrations, the ſulphate of lime formed in the proceſs of Scheele; 2. the examination of the liquor after evaporation, by oſſeous or calcareous nitrate, in order to aſcertain the preſence of the ſulphuric acid in it by the precipitation; 3. the portion of ſalt thrown up and not volatilized in the diſtillation of this nitric and phoſphoric liquor, by the jets formed in the thick liquid; 4. the decompoſition of the ſulphate of lime by the concentrated phoſphoric acid; 5. the ſtate of the opaque vitreous phoſphoric maſs remaining in the retort, and preſenting a mixture of this acid, of the ſulphuric, of baſe of bones or phoſphate of lime, and of ſulphate of lime; 6. the difficulty of ſeparating the pure phoſphoric acid from this maſs; the means of effecting this ſeparation by lixiviating, concentrating the lixivium by fire, and adding alcohol which precipitates the phoſphoric acid in white flakes; 7. laſtly, the fuſion of this acid, thus prepared and purified into a very white and very tranſparent glaſs, and the poſitive proof that the earth diſſolved by the nitric acid, and afterwards carried off by the ſulphuric, is really calcareous: a proof which conſiſts in precipitating it from the ſulphate depoſited by the carbonate of pot-aſh, and calcining the precipitate in order to reduce it to the ſtate of lime.

11. Citizen Nicolas, a chemiſt of Nancy, a ſhort time after the inquiry of Rouelle, gave a new and much more ſimple proceſs for extracting the phoſphoric acid from bones; a proceſs which contributed to elucidate their nature. Upon bones calcined to whiteneſs, pulverized, paſſed through the ſieve, and placed in a veſſel of ſtone-ware, an equal part of concentrated ſulphuric acid is poured; the mixture is ſtirred with a ſpatula of glaſs; and a ſufficient quantity of water is added to bring it to the conſiſtence of thin ſoup. After ſome hours contact and repoſe, during which it thickens, the mixture is placed upon a double linen cloth ſuſpended upon a ſquare frame; it is waſhed with water till it ceaſes to be acid, and to precipitate lime-water, or till the water has diſſolved all the phoſphoric acid: the mixed water are evaporated, and by means of the filtre, the ſulphate of lime is ſeparated in ſilky ſtraws or filaments, which are depoſited during the evaporation, and muſt be well waſhed with a little water. This ſeparation is continued till the liquor no longer depoſits any thing; the concentration is then continued ſo far as to give the liquor the conſiſtence of a ſoft extract: it is heated pretty ſtrongly in a large crucible, in which it ſwells and exhales a ſulphureous and aromatic ſmoke, in order either

to give it a ſemi-vitreous form, or even to vitrify it completely into a tranſparent glaſs without bubbles, which cannot be obtained except by keeping it fuſed for a ſufficient time. If it be propoſed to extract the phoſphorus from it, the operation is continued only till it has the conſiſtence of honey; for the phoſphoric glaſs does not afford this combuſtible body without great difficulty.

12. Since the publication of the proceſs of Citizen Nicolas, chemiſts have all contented themſelves with repeating it upon different kinds of bones, in order to compare them with one another, and to determine the quantity of phoſphoric acid which each of them is able to yield. Berniard has thus compared foſſil bones, thoſe of the whale, of the elephant, the porpoiſe, of the bullock, of man, the horns of the elk, the teeth of the ſeal, ivory. Bullion has extracted it from the bones of fiſh and from ivory, from which Rouelle had ſaid he was not able to obtain it. Citizen Vauquelin and myſelf, in our reſearches upon the animal matters, had occaſion to examine with much attention the phoſphoric acid extracted from bones, and to compare it with that produced by the deflagration of phoſphorus; from which it differs in ſome properties. We remarked that that of bones aſſumed by evaporation to a ſolid conſiſtence, the form of pearly ſtraws; that when thus dried, it attracted the humidity of the atmoſphere but very feebly;

that when fuſed into glaſs it was no longer acid, nor hardly ſoluble; we alſo found that the calcined bones, diſſolved in the muriatic acid, afforded likewiſe, by ſpontaneous evaporation, 0,33 of ſcaly cryſtals, brilliant, acidulous, fuſible into an inſoluble glaſs, becoming very ſoluble by any acid, and eſpecially by an exceſs of phoſphoric acid; that is, in every reſpect ſimilar to what is obtained from bones by the ſulphuric acid. The nitric, the acetous and the acetic acids, &c. gave us a ſimilar ſubſtance with the calcined bones. This matter, which reddens the blue colours, and is precipitable from its ſolution by ammonia, the cauſtic alkalis and lime water, into inſipid and inſoluble calcareous phoſphate, preſented us with all the properties of an acidulous phoſphate of lime.

13. We found by theſe firſt experiments that the bones were not completely decompoſed by the acids, though they all alike poſſeſs the property of ſoftening them and diſſolving their ſolid part; that their phoſphate of lime was only in part decompoſed; that the acids took from it only a portion of its baſe, and reduced it to the ſtate of acidulous calcareous phoſphate; and that there their action ceaſed. We afterwards found, by other experiments, that the acidulous phoſphate of lime might alſo be prepared with the baſe of bones and the phoſphoric acid; that this acid, when pure, decompoſed the muriate, the nitrate and even

the ſulphate of lime, leſs indeed than the two firſt, and thus formed acidulous calcareous phoſphate, always cryſtaliizable into ſmall brilliant and micaceous ſtraws; that this acidulous phoſphate contained 0,54 of phoſphoric acid, and 0,46 of lime; whilſt the phoſphate of lime, of bones, or the well ſaturated phoſphate, contained 0,41 of phoſphoric acid, and 0,59 of lime; that in treating the latter by the acids, only 0,24 of lime was taken from it; that 100 parts of calcined bones, treated by the ſulphuric acid were charged into 76 parts of acidulous phoſphate, formed of phoſphate of lime 59, and of phoſphoric acid 17 parts; that there were only theſe 17 parts of free acid which afforded phoſphorus in the diſtillation with charcoal; that the portion of neutral phoſphate of lime remained in the reſiduum of this operation, and that it was on this account that from 100 parts of bones, according to the moſt exact calculations of Pelletier, who has given excellent details upon this preparation, only 0,05 of phoſphorus, at moſt, were obtained; whereas the 100 parts of bone really contain 0,16 to the 0,41 of phoſphoric acid which they contain.

14. This knowledge which we acquired concerning the ſemi-decompoſition only of the oſſeous calcareous phoſphate, by the acids, and the formation of an acidulous phoſphate, afforded uſeful reſults for the extraction of the

phoſphoric acid of bones, their analyſis, the preparation of phoſphorus, and even for oſteogeny.

Calculation and experiment have taught us that only $\frac{2}{5}$ of their weight of concentrated ſulphuric acid muſt be employed for decompoſing the calcined bones, inſtead of $\frac{2}{3}$ which chemiſts had directed.

In order completely to analyſe the bones, and to aſcertain the proportion of phoſphoric acid and lime which they contain, after having diſſolved their earthy baſe by any acid, as the nitric or the muriatic, this ſolution muſt be precipitated by the oxalic acid, which decompoſes the acidulous phoſphate of lime, like all the other calcareous ſalts, and conſequently leaves the phoſphoric acid nearly free in the liquor, ſwimming above the precipitate which it forms, which containing in 100 parts 0,48 of lime, thus indicates the quantity of this earth. No alkaline carbonate decompoſes the acid phoſphate of lime, nor conſequently can they ſerve for this complete analyſis.

As that which is obtained from bones treated with the ſulphuric acid, yields phoſphorus only in proportion to the exceſs of phoſphoric acid in the acid phoſphate of lime, if we treat the lixivium with nitrate or acetite of lead, we decompoſe completely, and by neceſſary double elective attraction, the acid phoſphate of lime; all its phoſphoric acid is depoſited in union with the lead; all its lime remains in ſolution, combined with the nitric or acetous acid. The precipitate well waſhed, and diſtilled with charcoal, affords a quantity of phoſphorus, more than twice as large as the ſimple product of the evaporation of what was called *phoſphoric acid of bones;* we thus obtain from 0,08 to 0,12, inſtead of 0,05, which had hitherto been extracted.

The very eaſy and abundant ſolubility of the oſſeous phoſphate of lime in the phoſphoric acid, and the ſpeedy formation of acid calcareous phoſphate, explain a ſeries of important phenomena relative to oſteogeny and the diſeaſes of the bones, which are not to be detailed here, but which will be found elſewhere.

15. The cauſtic alkalies, and the alkaline carbonates have no action upon the oſſeous phoſphate of lime, and do not effect any decompoſition of it, though chemiſts have thought ſo, and have even propoſed to fuſe calcined bones with the carbonate of pot-aſh, or of ſoda. It is a fact, of which Citizen Vauquelin and myſelf have well convinced ourſelves, and which we have confirmed by very exact experiments. It will be ſeen hereafter that this impoſſibility of decompoſing the phoſphate of lime by the carbonate of pot-aſh, either in the dry or in the humid way, oppoſed to the facility with which the oxalate of lime is decompoſed by the ſame ſalt, has afforded much light reſpecting the analyſis of ſeveral

kinds of urinary concretions. The alkalies and their carbonates, in ſolution, act upon the gelatinous matter of the bones, which they thus ſoften, and the extraction of which they favour. No ſalt has any real action upon the oſſeous texture.

The metallic oxides, and their ſolutions in the acids, burn its membranous part more or leſs powerfully, or colour it, at the ſame time penetrating it, when they are diluted with water; in this manner it is that the ſolutions of copper turn the bones that are expoſed to their contact green, and artificial turquoiſes are formed in pieces of bones, ſuſpended in very weak nitrid acid, or even in other liquids, when only a mere pin of copper is at the ſame time immerſed along with them.

16. Amongſt the vegetable matters, if we except the acids already indicated, we know only the oils and ſome colouring matters that are capable of penetrating the oſſeous texture, undoubtedly in its gelatinous ſubſtance, and giving it either an unctuous flexibility, or a ſoft poliſh, or a more or leſs intenſe colour. It is known, relatively to this laſt mentioned fact, how eaſy it is to dye the oſſeous ſurface, and even to cauſe the colour to penetrate conſiderably between their deep-ſeated layers; and alſo how ſtrongly the colouring matter adheres, and what livelineſs it aſſumes in them, as is exemplified in the various toys of ſtained bones which are daily manufactured. We alſo ſee a ſtriking

proof of this adheſion of the colouring matters with the bones in the brilliant roſe-colour, which the bones of living animals contract from madder, mixed with their aliments. The fine tinge which this vegetable gives them ſeems to announce that its colour is brightened by an acid before it is depoſited amongſt the oſſeous laminæ.

Amongſt animal matters, the fats and the coloured ſubſtances act like the preceding bodies upon the bones; the acids which are produced by the ſpontaneous alterations of theſe living matters, diſſolve the phoſphate of lime, and ſoften the oſſeous texture as eaſily as thoſe which belong to the foſſils or to the vegetable compounds.

17. The whole of the facts relative to the oſſeous texture prove that it is a compound of two principal ſubſtances, a gelatinous or glutinous baſe, and an inſoluble ſalt. The firſt conſtitutes its true organic type; it is this which exiſts at firſt as membrane, as cartilage, and which gradually becomes filled by the progreſs of oſſification in young animals, with ſmall cryſtals of phoſphate of lime which furniſh its areolæ, and there aſſume the granulated, lamellated, cellular form, which is determined by that of theſe primitive areolæ, after the manner of a kind of mould. The firſt diſſolves in water, is gradually decompoſed, and leaves the bones brittle in proportion as its quantity diminiſhes. The other being ſoluble in all the acids which carry it off, reduces the bone in proportion as it

is diſſolved to its primitive cartilaginous or gelatinous nature. The one gives the primitive form, the pliability, the ſoft and poliſhed texture. The other produces the ſolidity, the hardneſs, the reſiſtance, and the permanent form. The firſt if it predominates, permits the bones to extend themſelves, to form apophyſes, ſinuoſities, and depreſſions, by the attracting action of the muſcles and the compreſſing action of the arteries &c. The ſecond, when it comes to be predominant, oppoſes the change of form, renders the bones dry and brittle, frequently adds to their thickneſs, renders them deformed, enlarges them irregularly, and fills their cavities.

18. But though the general and in ſome ſort common or average nature of the bones is at the preſent day well known; though their analyſis throws ſome light upon their formation and the alterations of which they are ſuſceptible; yet much ſtill remains to be done, and what lights may we not expect from future labours and reſearches upon the bones of the fœtus compared with thoſe of the adult and of old men; upon thoſe of the different animals compared with the human bones, eſpecially in the inferior orders of the amphibia and of the fiſhes, whoſe organs and functions, ſo different from thoſe of man muſt produce ſuch remarkable differences in the nature and compoſition of their parts. How many intereſting facts will be preſented to phyſiologiſts by a well conducted examination of bones that have

been buried for a longer or ſhorter time in the earth, expoſed to the air or immerſed in the water, and changed more or leſs conſiderably in their intimate nature, either by the ſubſtraction of ſome of their conſtituent materials, or by the addition of ſome foreign matters.

19. A vaſt career is ſtill open to chemiſts, if they chooſe to apply the means which they already poſſeſs to the highly intereſting experiments upon oſſification, and the regeneration of the bones, commenced under other relations by Duhamel, Fongeroux, Haller and Troja; if they compare the progreſs of the formation and the ſolidification of theſe organs in the fœtus and in the young animal, at different periods, with the quantity and the nature of its aliments; if by varying theſe, and adding to them ſubſtances which are known to influence the colour and the conſiſtence of the bones, they follow with all the requiſite attention the relations of both; if they multiply theſe uſeful experiments in animals of different orders, in the frugivorous and carnivorous mammalia, in the aquatic fowls and the birds of the foreſt, in the amphibia, and even in the fiſhes; if by laying bare the bones in ſome points in theſe living animals and inveloping the oſſeous parts with different ſubſtances, or with different elaſtic fluids, they thereby appreciate the influence of theſe contacts and the kind of alteration to which they give riſe; if the external irritation and the deſtruction of the external perioſteum, with the in-

ternal irritation and the diſorganization of the marrow, be obſerved with care, and combined with the other modes of experimenting adopted by Duhamel and Fougeroux.

20. The proſpect enlarges and affords hopes of ſucceſs ſtill much more important than the preceding, when theſe exact analyſes, theſe valuable reſearches ſhall have been extended to diſeaſed bones, ſoftened as it were, fuſed in the Rachitis, the lacteal affections, hardened and ſwelled in exoſtoſes of different kinds, corroded and deſtroyed in different kinds of caries, dry or humid, ſlow or rapid; ſplit, diſtended, inflated in the *ſpina ventoſa*, the necroſis; re-formed, regenerated, doubled in the ſequeſtra, fractures, callus. All theſe alterations ſo well deſcribed and known by the moderns, in which they have found ſubjects of obſervation which had eſcaped the ancient phyſicians, and views of treatment, with motives for prognoſticating the cure which had been intirely neglected before; theſe cannot be really underſtood, nor their cauſes appreciated, their curative treatment reſcued from the mere empiriciſm that has hitherto directed it, unleſs by poſitive experiments, well inſtituted analyſes, for which the preſent ſtate of chemiſtry preſents means ſo new and ſo ſuperior to thoſe which the ſcience formerly poſſeſſed.

ARTICLE XIII.

Of the Animal Matters contained in the Oſſeous Cavity of the Cranium, or proceeding from it.

1. IN the twelve preceding articles, we have ſpoken of the different liquid and ſolid matters which are generally diffuſed throughout the whole body, and which conſtitute, as it were, its ſolid elements. In the preſent article we ſhall treat of the matters which are found in the cavity of the cranium. We ſhall not, however, ſpeak of the membranes, the dura mater, the pia mater, and the arachnoid; nor of the ſanguineous veſſels, as theſe bodies preſent nothing different from what has been ſet forth in general concerning the membranous and vaſcular texture, in one of the preceding articles. We ſhall treat of the cerebral matter, of the nervous fluid, of the liquor of the ventricles, and of the pineal concretions: theſe are in fact the four ſubſtances particularly contained in the cranium, and which, preſenting an aſpect, a ſtructure, or phyſical properties different from theſe which occupy other cavities of the body, conſequently deſerve a particular examination. Two of theſe matters belong to the animal liquids, another to the ſoft part, and the laſt to the ſolids.

SECTION I.

Of the Cerebral and Nervous Pulp.

2. THE brain, this viſcus ſo regularly organized, and ſo voluminous in man, in whom it exceeds in weight the relative quantity contained in the cranium of any other animal, is furrowed at its ſurface into a multitude of grooves, elevated into protuberances at a number of points, preſenting tortuous inequalities which have been compared to the inteſtinal circumvolutions, forming, at a ſmall depth beneath this unequal and, as it were, carved ſurface, a homogeneous maſs, of a grey colour externally, in its cortical layer, or cineritious ſubſtance, it is of a milk or ivory-white colour in its interior, preſenting in its continuity an admirable ſeries of forms, of colours, of protuberant, rounded, elongated parts, of cords, cavities, and tubercles, conſtant and regular in all individuals. This organ, which the anatomiſts, and eſpecially Soemmering and Vicq-d'-Azyr, have ſo well deſcribed, without however having been able to ſay any thing concerning the uſes of all its very diverſified parts; this anatomical and phyſiological enigma, which no naturaliſts has yet been able to unravel, repreſents a kind of thick paſte, of a more or leſs

ſolid pulp, divided into the cerebrum properly ſo called, the cerebellum,, and medullary prolongations, which proceeding from theſe two centres, give riſe to the medulla oblongata, to the pairs of nerves, and to the ſpinal marrow. The nerves which proceed from the baſe of this viſcus, and thoſe which paſs from the ſpinal marrow to diffuſe themſelves throughout the whole body, and give it the cauſe of motion and ſenſation, are themſelves real cerebral emanations, covered with membranes borrowed from the membranes of the medulla itſelf, from which they detach themſelves, and relinquiſh them where they enter the parts to which they communicate the powers of motion and ſenſation.

3. The curious form and ſtructure which this viſcus exhibits, its ſize and quantity correſponding with the intellectual faculties of the animal, the ſenſes which are contiguous to it, and, as it were, its neareſt appendages, the internal ſenſation which appriſes every one that the conſciouſneſs of his actions, his deſires, his will, the exerciſe of all the faculties of his mind refer themſelves to the interior of his head; the leſion of the function of the nerves, of motion, of ſenſation, even of thought, the madneſs, the fatuity which conſtantly accompany morbid changes produced around or in the interior of the cerebral texture, of whatever nature they may be; the lethargy, the imbecility, the fatuity, the idiotiſm, which are the

conſequences of preſſure applied to theſe organs—all announce that the brain is the ſeat of the ſenſations, the ſenſorium commune, the grand focus of life, and the general ſource of the functions, which are called *animal* or *intellectual.* The anatomy of animals, purſued in all the orders of theſe organized beings, from man down to the teſtacea and worms, confirms this general notion, by ſhowing the progreſſive degradation of the organization, of the maſs, and of the different portions of this viſcus, correſponding with a kind of ſtriking preciſion with the diminution of ſenſibility, of intelligence, of inſtinct, and of ſenſitive organs in theſe beings.

4. Incomprehenſible to the moſt able anatomiſts, who have beſt underſtood and demonſtrated its numerous circumvolutions, its moſt hidden ſtructure, its moſt delicate parts, this viſcus preſents no more hold, or rather it affords no more ſatisfactory reſults to the chemiſt than to the phyſiologiſt, who has examined only its ſtructure. The one, after the moſt perſevering labours, is no leſs aſtoniſhed than the other, at the ſmall degree of relation which he finds between his reſult and the properties of this living organ. Few learned men have yet occupied themſelves with the analyſis of the cerebral pulp, or medulla; and, before the moſt modern times, they had not even the curioſity to attempt to inveſtigate its nature and compoſition; there were ſcarcely more than a few facts,

borrowed from the art of cookery, or obſerved in the proceſſes employed by anatomiſts for demonſtrating the different parts of the brain, that had afforded a ſuperficial notion of its chemical properties. Garman had announced its ſingular preſervation in the oſſeous cranium of buried bodies. Burrhus had compared its texture with an oil, and had even conſidered it as approaching to the nature of ſpermaceti. Citizen Thouret firſt deſcribed a ſeries of experiments upon the nature of the medulla of the brain, in a Memoir publiſhed amongſt thoſe of the Society of Medicine, and repreſented it as a kind of ſaponaceous ſubſtance, compoſed of an oil and fixed alkali. I publiſhed, in March, 1793, in the Annales de Chimie, tom. XVI. an analyſis of the human brain, and of that of ſeveral of the mammalia, of which I ſhall here preſent a notice.

5. The human brain, which I ſhall take as the example and type, freſh and cut into ſlices, placed in a flaſk with a tube, immerſed under a bell glaſs full of water, at 20 degrees of temperature, give out at firſt ſome bubbles of carbonic acid, but it afterwards preſented no gas during more than a year; it exhaled a bad ſmell without experiencing any real fermentation, or very perceptible alteration in its ſubſtance, &c.

Expoſed to the air, at a temperature exceeding 12 degrees, the brain becomes very fetid, aſſumes a green colour, putrefies, but nevertheleſs acquires acidity, and reddens blue paper.

Dried on the water-bath it firſt coagulates, a ſmall quantity of water is ſeparated from it, and it diminiſhes from $\frac{4}{5}$ to $\frac{7}{8}$; it grows leſs, becomes yellow; it kneads and balls under the fingers. When afterwards ſtrongly heated in an earthen crucible, it exhales ammonia, ſoftens, ſwells, becomes brown and black, melts, diffuſes thick and acrid fumes, inflames, remains for a long time ignited after the diminution and ceſſation of its flame; it then affords ſulphureous acids, produced by the combuſtion of the ſmall quantity of ſulphur which it contains, melts in this ſeemingly coally ſtate, acquires a ropy liquidity, becomes fixed into a ſort of blackiſh and brittle bitumen, and affords no trace of alkali in its lixiviated coal. When the dried brain is treated in the retort, we obtain from it water charged with ſeveral ammoniacal ſalts, a conſiderable abundance of oil, concrete carbonate of ammonia, carbonated and ſulphurated hidrogen gas, and carbonic acid. We find ſome traces of phoſphates of lime and of ſoda, but no free in its coal.

6. The cerebral pulp diluted with water, and ſuſpended in it like a thick emulſion, is coagulated by heat, and ſeparates into flakes like milk treated with an acid. The liquor, ſeparated from the flakes, is precipitated by lime-water and by the calcareous ſalts; it becomes coloured as it evaporates; it affords phoſphate

of ſoda by cryſtallization. All the brains of the mammalia and birds preſent the ſame character of being diluted in water by trituration, and ſeparating from it in coagulated flakes by the action of heat. This viſcus and glairy ſolution froths by agitation, and reſembles a ſtrong ley of ſoap ſo nearly, that it might be miſtaken for it by its appearance. A part of this cerebral matter ſuſpended in the emulſive form, ſwims like a kind of cream at the ſurface of the liquor. Alcohol coagulates and precipitates, in condenſed flakes, the matter of the brain thus diluted and ſuſpended in water. It is alſo to be obſerved, that this liquor, of an emulſive or ſaponaceous appearance, does not alter the vegetable colours; the acids decompoſe and coagulate it. The cerebral pulp, ever after its coction, and the kind of hardneſs of coagulation, which it experiences to dryneſs, when heated on the water-bath, after having ſuffered a portion of this liquid to eſcape, and having aſſumed, in the kind of dryneſs which it acquires, a fawn-colour, whilſt it is reduced to a fourth or fifth of its primitive weight, has not loſt all its attraction for water; it may ſtill be diluted in it by mere trituration, and preſents a yellowiſh emulſive liquor, which indeed is quickly decompoſed, throws down flakes of hardened pulp, and retain only ſome ſoluble ſalts.

7. The brain dried, baked, and even beginning to roaſt, in the manner of thoſe vegetable

ſubſtances from which oil is obtained by preſſure, being placed betwen two hot plates of iron, and ſubjected to the action of a preſs with a lever a metre in length, and moved by two men, did not yield a ſingle drop of liquid oil. This experiment, indicated by Burrhus, who aſſerted that he had extracted a concreſcible oil, from the dried brain, had no ſucceſs; and there is reaſon to believe, that this author employed brain already altered, either by time, or by the proceſſes to which he had firſt ſubjected it. This property of affording a concrete oil, or rather of having almoſt its whole maſs converted into a concreſcible oil, analogous to ſpermaceti, is however acquired by the cerebral pulp, by means of the gradual putrid decompoſition which it undergoes in buried bodies. This is one of the curious obſervations that were made by Citizen Thouret and myſelf upon the bodies with which the ground of the burying place of the Innocents in Paris, was filled to a great depth. They all preſented in their cranium the maſs of the brain leſſened, contracted, occupying not more than from a tenth to a fifteenth of the volume of this cavity, frequently moving freely within it, of a much firmer conſiſtence than in its natural ſtate, of a blackiſh or dark-brown colour in its interior part. This pulp, thus dried and hardened, preſenting no longer either the external form or the internal appearance of the brain from which it had its origin, was brittle, ſoftened under the finger, was diffuſible in water, exhaling a faint diſagreeable ſmell, and preſented all the characters of an ammoniacal ſoap. It afforded by the acids which decompoſed it a thick, fatty, oily, fuſible precipitate, which became fixed into cryſtalline laminæ by cooling, was ſoluble in alcohol, and in ſhort, poſſeſſed many properties analogous to ſpermaceti. But it is very evident that this oily matter does not exiſt ready formed in the brain, and that it is the product of a ſeptic alteration, which announces indeed, in the cerebral pulp, a greater diſpoſition than in many other animal ſubſtances to acquire this form and this character of an adipocirous oil.

8. The cerebral pulp being diluted in water, and mixed with ſulphuric acid, coagulates into flakes, which may eaſily be ſeparated from it and obtained upon the filtre. The filtrated liquor contains a ſmall quantity of animal oil, which burns, is decompoſed, and precipitates carbon by the progreſs of the evaporation. We find in it lime, ſoda, ammonia, united either in part or wholly with the ſulphuric acid that has been added, and free phoſphoric acid. The coagulated matter does not preſent the oily characters, but thoſe of a concrete albumen.

Weak nitric acid decompoſes the brain in the ſame manner; the concentrated nitric acid immediately coagulates it, diſengaging from it azotic gas, produces conſiderable motion, effervеſcence, and foam, almoſt produces inflammation. It leaves to a coally, ſwelled and voluminous matter, and exhales a mixture of nitrous gas, carbonic acid gas, and ammoniacal gas. We find phoſphate of lime, oxalate of lime, and oxalate of ſoda in the ley, and in the aſhes of the coal obtained by this experiment.

Muriatic acid poured upon the human brain, diluted in water, ſeparates from it coagulated flakes which ſwim at the ſurface. The liquor cleared by repoſe, and ſeparated from the coagulum by the filtre, being evaporated by a gentle heat, affords tranſparent pellicles which blacken at the end of the operation: we extract from it by the ſame evaporation, and by abſorbing the exceſs of acid by means of ammonia, ſoda, lime, and phoſporic acid, united partly with each other, and partly with the muriatic acid. The coagulated and dried part is about a tenth or twelfth of the original weight of the brain employed; it preſents all the properties of a concrete albuminous matter.

9. The leys of cauſtic fixed alkalis act powerfully upon the cerebral pulp. This action takes place even in the cold: much caloric and ammonia are diſengaged. This laſt effect, which is obſerved even upon freſh brains, preſents itſelf even with ſuch as are already acrid. The medullary pulp becomes greyiſh, and ſometimes of a light roſe colour. When its ſolution is effected by heat, it comports itſelf like a ſoap. This effect reſembles what has been ſtated elſewhere

where concerning the action of the alkalis upon the animal ſubſtances in general, and it depends upon the alteration which the albuminous cerebral ſubſtance experiences at the very moment of the mixture. The opoſite effects of oils heated with the ſubſtance of the brain is ſufficiently known, as this is an experiment which is conſtantly made in boiling and frying this alimentary ſubſtance in oil; one part, nearly the half, diſſolves and gives to the fixed oil a pretty ſtrong conſiſtence: the other dries, contracts, coagulates, bakes, and aſſumes a denſity, an agreeable taſte, with an inſolubility which it did not poſſeſs before.

10. The action of alcohol upon the cerebral pulp, deprived of a great part of its water by deſiccation, is one of the moſt ſingular phenomena which this ſubſtance has preſented to me. When treated four times in ſucceſſion with twice its weight of well rectified alcohol, and by an ebullition of a quarter of an hour each time, in a mattraſs with a long neck provided with a grooved ſtopper, in order that as little alcohol as poſſible may be loſt, the three firſt portions of alcohol decanted boiling, depoſited by cooling brilliant laminæ of a yellowiſh white colour, leſs in quantity each time; the fourth ſcarcely depoſited any thing. The cerebral matter loſt $\frac{5}{8}$ of its weight; and I obtained in all, by the ſpontaneous depoſition and by the total evaporation of the alcohol, $\frac{2}{8}$ and a half of needled cryſtals, of large plates,

or of granulated or more condenſed matter. There were, as is evident, $\frac{2}{8}$ and a half loſt in water volatilized with the alcohol. This cryſtallized ſubſtance, of a fatty appearance, became agglutinated into a paſte under the finger; it did not melt in the heat of boiling water, but was merely ſoftened. At a higher temperature, it ſuddenly acquired a blackiſh-yellow colour, and exhaled during its fuſion an empyreumatic and ammoniacal odour. It had therefore no real analogy with ſpermaceti, which melts between 32 and 35 degrees, nor with the fat matter of putrefied bodies, which melts at 28 degrees; it ſeems more to reſemble the fat lamellated cryſtals contained in the biliary calculi, which do not ſoften even at 90 degrees of Reaumur's ſcale. This latter ſubſtance does not become either ammoniacal or empyreumatic at this temperature, like the cryſtalline cerebral oil extracted by alcohol.

11. I muſt here obſerve that the portion of this concrete oil, ſeparated from the alcohol which had diſſolved it by evaporation in the ſun, and which had formed itſelf into a granulated pellicle at its ſurface, in conſequence of the particles being rapidly attracted towards thoſe placed in the centre; preſented ſome properties modified in a different manner from thoſe of the portion of the ſame oil depoſited ſpontaneouſly by the cooling of this alcoholic ſolution. It was a little more abundant than the firſt, of a deeper yellow colour, having a very marked

ſmell of animal extract, and a very perceptible ſaline taſte; its ſoft conſiſtence reſembled that of black ſoap; it was diffuſible in water, gave it a milky appearance, reddened turnſole paper, and did not become really oily or fuſible after the manner of an oil, till after it had diſengaged ammonia, and depoſited carbon by the action of fire, or of the cauſtic fixed alkalis; it was therefore a little different from the preceding; which indicates that the cerebral pulp does not aſſume this oily character, by partial ſolution in alcohol, unleſs by an alteration which it begins to experience in its principles and its compoſition. It appears that it undergoes a ſimilar change by merely remaining in cold alcohol; for the brain and its different ſections, the nerves themſelves, the cerebellum, the ſpinal marrow, all matters of the ſame chemical nature as they belong to the ſame anatomical continuity, when immerſed and intirely macerated in alcohol, depoſit. at the end of ſome months, ſmall brilliant plates or ſtraws, like cryſtals of boracic acid, which are precipitated, and collected at the bottom of the veſſels which are kept in cabinets of anatomy, as we may ſee in thoſe of the School of Medicine of Paris, and the Veterinary School of Alfort. We are even obliged, from time to time, to renew the alcohol in theſe veſſels, and to clean them in order to expoſe the matters which they contain to view; but it is evident that theſe muſt entirely decay, and that whatever

ever they contain of medullary ſubſtance will be ſucceſſively changed by paſſing into the adipocirous ſtate.

12. I have concluded from theſe experiments, of which I have juſt preſented the reſult, that the medullary pulp is a particular ſemi-concrete albuminous matter, more oxigenated than that which exiſts in the ſerum of the blood, containing no free alkali, mixed with a large quantity of water, which gives it the form and conſiſtence of a pulp, and which at the ſame time contains ſome phoſphates in ſolution; that this ſpecies of matter being analogous to white of egg half boiled or hardened, is not a fatty ſubſtance, nor conſequently an alkaline ſoap, as had been thought; that it is more eſpecially remarkable by its property of paſſing into the adipocirous ſtate by putrefaction, which at firſt acidifies it, by the action of the cauſtic alkalis, and by that of alcohol; that this ſubſtance is immediately ſeparated from the blood by the numerous arteries which enter the cranium, and traverſe the texture of the brain in ſuch quantity, that this viſcus has been conſidered by able anatomiſts as formed of vaſcular extremities intermingled and implicated in tortuous windings. It is almoſt ſuperfluous to add, that the centre of the nervous chords is exactly of the ſame nature with the cerebral pulp, as theſe nerves are only elongations or elongated filaments of the brain.

SECTION II.

Of the Nervous Fluid.

13. MOST phyſiologiſts admit a very light and very moveable fluid, almoſt to be compared with the electric or magnetic fluid, which they believe to flow by the impulſe of the will or of any irritation from within the brain, or the cerebellum, or the medulla oblongata, or the ſpinal marrow into the nerves; and the uſe of which they conſider to be that of conveying the cauſe of motion and ſenſation. They cannot, however, give any other proofs of its exiſtence than the diminution or ceſſation of the nervous action in conſequence of ligatures applied to the nerves, or of a compreſſion which they imagine muſt impede or ſtop the motion of this fluid. There is no cavity in the nervous chords; we ſee in them no other matter than the medulla which occupies their centre, and a mucous liquor which moiſtens their membranes. This difficulty vaniſhes with thoſe who repreſent this fluid as poſſeſſing a tenuity ſuperior to that which is known in any of the viſible animal fluids: it not only eſcapes our ſenſes, but the imagination itſelf can ſcarcely comprehend its velocity.

14. In admitting this fluid, it muſt be ſuppoſed to have either two oppoſite kinds of motion, which is difficult to be conceived in the ſame nerves; or elſe two kinds of nervous channels, the one carrying the ſenſitive fluid from the organs of the ſenſes affected from without into the brain, the ſeat of the *ſenſorium commune*, the others conveying it from the brain into the viſcera and the muſcles, in order to carry into them the principle of life and of independent motion, which is ſupported in the former, and the command of the will which ſolicits and provokes it in the latter. It muſt moreover be admitted, that this nervous fluid can follow only a ſingle courſe, whether in one o in the other of theſe channels, for it cannot return againſt itſelf, and conſequently, it would appear to be diſſipated after its effect has been produced, which accords with its extreme tenuity and the great velocity of its motion. It is undoubtedly on account of theſe difficulties that ſome phyſiologiſts have denied the exiſtence of that fluid which others had called *animal ſpirits*, and that they have thought they could explain the functions which were attributed to it, either by a rapid impulſe communicated to an uninterrupted globular texture in the brain and the nerves, or by a vibration excited on the filaments of thoſe organs. In fact, theſe two hypotheſes are attended with no leſs difficulty than that of the exiſtence of a fluid, ſince they ſuppoſe a tenſion, a rigidity, or ſolidity in

the nervous fibres, which the moſt ſimple obſervation leads us to reject.

15. No experiment, nor fact, can throw the ſmalleſt light upon or give the moſt ſimple notion of the nature of the nervous fluid. It is intirely and perfectly unknown to thoſe who admit it, and who have no doubt of its exiſtence. It has been ſuppoſed to be the ſame with the electric fluid, but the nerves exhibit no ſign of electricity; and though ſome experiments ſeem to prove, that after death they are very good electric conductors, none can lead us even to ſuſpect its exiſtence in the nervous ſyſtem, and its paſſage, as well as its accumulation in the different regions of that ſyſtem. To admit, ſince the diſcovery of Galvani reſpecting metallic irritation, a particular fluid different from the preceding, of which the brain ſhould be the reſervoir, and the nerves its different ducts, would be the fabrication of an hypotheſis deſtined to be inceſſantly overturned by new reſearches. Some have ſuppoſed the nervous fluid to be a gas, more eſpecially oxigen gas; but it would require hollow tubes to conduct it, and nothing of this kind is known either in the brain or in the nerves. It muſt therefore be admitted, that we are abſolutely ignorant of what the nervous fluid may be, as well as of the general mode in which the action of the brain and of the nerves conſiſts.

SECTION III.

Of the Fluid of the Ventricles of the Brain.

16. IN the ventricles of the brain, as well as between its membranes and its ſurface, is found a ſlightly viſcous fluid, which inceſſantly exudes from the arterial extremities, which lubricates and ſoftens the ſurfaces between which it exiſts, and prevents them from forming adheſions with each other, as is alſo found in all the other cavities between the ſurfaces of the membranes of the body. Authors improperly call it a vapour. It is inceſſantly ſucked up by the abſorbent veſſels, or by the veins. It ſometimes accumulates and forms dropſies of the head of different kinds. A ſimilar liquid exiſts in the middle cavity of the ſpinal marrow and between its membranes. This humour does not appear to differ from that which lubricates all the membranous cavities of the human body in general, and of which I have already ſpoken. It is a mucoſo-gelatinous liquid, more or leſs albuminous, and containing ſome ſaline matters. It is the ſame matter which filtrates between the fibrous faſciculi of the cerebral medula, and renders them ſoft and pulpy.

SECTION IV.

Of the Pineal Concretions.

17. EVERY anatomiſt knows that the pineal gland, the uſes of which are abſolutely unknown, frequently contains in the interior of its pulp, two or three ſmall hard concretions, which are found in it by cruſhing this glandular body between the fingers. Theſe concretions are ſo common, that very few brains are opened in the anatomical theatres in which they are not met with. They are generally ſo ſmall and ſo light, that it is neceſſary to collect ſeveral of them together, in order to be able to examine them. About twenty of them are required to form a gramme. They are irregularly rounded bodies, with aſperities and points at their ſurface, never ſmooth and poliſhed. I have found them to be compoſed of phoſphate of lime united to about one third of their weight of gelatinous matter. As the calculi of the pineal gland are ſo frequent in the human brain, and as they do not appear to produce diſeaſes, they may be conſidered almoſt in the light of natural concretions, or depoſitions, the formation of which, in this ſingle region of the brain, is indeed a ſingular phenomenon, the cauſe of which deſerves to be inveſtigated by anatomiſts.

ARTICLE XIV.

Of the Liquids peculiar to the Eye; of the aqueous, vitreous and cryſtalline Humours, and of the Tears.

1. THOUGH I here indicate in particular, as humours of the eye, thoſe only which are known by the name of aqueous, vitreous, and cryſtalline humours, and tears; this admirable organ contains alſo ſeveral other liquid, ſoft, or ſolid ſubſtances, which would deſerve a particular examination, but with which chemiſtry has not yet been occupied. We are entirely ignorant of the nature of the black *pigmentum;* of the choroid, which appears to be carbon; of the ſoft and tranſparent pulp of the retina, the principal ſeat of viſion, and which is certainly not a ſimple albuminous humour, as its aſpect ſeems to announce; of thoſe hard and thin membranes which form the ſhell of the eye; of that brilliant, pearly, gold-coloured lining which inveſts the internal ſurface of the globe of the eye. We have ſcarcely yet occupied ourſelves, or to ſpeak more properly, we have as yet only ſome preliminary, and as it were proviſionary notions of the vitreous, aqueous, and cryſtalline humours, according to the experiments of Petit and Chrouet, who have publiſhed a Diſſer-

tation upon the humours of the eye. The tears are a little better known.

2. The aqueous humour is contained, in the proportion of from a quarter to a third of a gramme, in the two chambers of the eye, the anterior and the poſterior, between the ſurface of the tranſparent cornea and the cryſtalline humour. It is ſeparated by the arteries of the ciliary proceſs and of the iris; it runs out in part by the pores of the cornea, where it is taken up again by the abſorbent veſſels. Its renovation is ſo prompt, that after it has been evacuated in the operation of the cataract by the aperture made in the cornea, it is renewed and diſtends this membrane within twenty-four or thirty-ſix hours. Halloran has ſeen a gramme and one-third of it flow in twelve minutes from a wound in the eye. Bertrandi thought it was lighter than water, in the proportion of 975 to 1000; but there is reaſon to believe that this is an error. It is perfectly tranſparent, has a ſlightly ſaline taſte, and a very great liquidity. It evaporates intirely and without reſidue. The acids and alcohol do not effect its coagulation; the nitric acid, the nitro-muriatic acid, and eſpecially the oxigenated muriatic acid, have the property of rendering it a little turbid. Though little charged with animal matter, it putrefies and exhales a bad ſmell. We find in it alſo ſome traces of alkaline phoſphates, of ſoda, and of muriate of ſoda. Its uſe is to diſtend the cornea and ſupport its rounded form,

and retain the cryſtalline and the vitreous humours in their poſition. It ſometimes accumulates to ſuch a degree as to puſh the cornea before it in a hideous manner in the hydrophthalmia: it is ſeemingly gelatinous in the tortoiſe and in ſome fiſhes.

3. Scarcely any thing has yet been ſaid concerning the nature or the compoſition of the vitreous humour; it derives its name from its tranſparency and its aſpect, which reſembles melted glaſs. Incloſed in membranes, or very cloſe membranous cells, it occupies all the bottom of the globe of the eye from the poſterior ſurface of the cryſtalline to the ſurface of the retina; it is ſlightly reddiſh in the fœtus, and is never known to become opaque in old age. The exact degree of its denſity is not known; but it is known to be ſuperior to that of the aqueous humour, and inferior to that of the cornea. Wintringham found it relatively to water, as 10024 to 10000. Its quantity is conſiderable, for, according to Petit, who has given both in the Memoirs of the Academy of Sciences, of Paris, for 1728, and in particular letters, an exact deſcription of the parts and of the humours of the eye, it conſtitutes of itſelf more than two-thirds of the weight. Some of its chemical properties have been indicated by Petit, Chrouet, Mauchart, and Zinn. It does not coagulate in boiling water; it is evaporated intirely by the fire; it contains but very little ſalt and earth; the powerful acids and the fixed

alkalis render it a little turbid. It becomes glutinous, thick, even concrete, and more or leſs opaque in ſome diſeaſes, eſpecially in the glaucoma. Duhamel ſaw it once ſenſibly reddened in an animal to which he adminiſtered madder.

Boerhaave obſerved already long ago, that a wound made into the vitreous ſubſtance ſuffered the humour of this ſubſtance to run out only in a ſucceſſive, gradual manner, drop by drop, whence he concluded that this humour was contained in numerous cells communicating with each other, narrower in the interior and wider at the outer part of this body, to which its apparent viſcidity is owing; for when we ſuſpend a vitreous humour by a thread over a veſſel, in proportion as the humour runs out, the ſmall diviſions of the membrane contract, diſappear by approaching each other, and the liquid collected is as thin and as fluid as water.

4. The cryſtalline lens, ſeated in the anterior foſſa of the vitreous ſubſtance, and incloſed in its particular capſule, is an almoſt ſolid or ſemi-concrete body, like a very thick jelly, of a lenticular form, the form, the curvature, and the internal ſtructure of which have been carefully inveſtigated and deſcribed. It has a diameter of about four lines in man, and the average amount of its weight is a quarter of a gramme. It is heavier than water, and ſinks to the bottom of this liquid. Very ſoft in the fœtus, it grows hard in old perſons, and by the

progreſs of age it gradually paſſes from a perfectly colourleſs and tranſparent ſtate into a yellowiſh colour, like topaz or amber, with a ſlight obſcurity. It is very eaſy to be cut or divided; preſſure bruiſes and extends it, and ſeparates the greater part of its particles.

It has long been known that it is ſuſceptible of becoming opaque, cartilaginous, oſſeous, and even of an almoſt ſtony hardneſs. The example of fried fiſhes ſhows us that the cryſtalline lens becomes concrete by the action of heat; that it is rendered white and friable, like a kind of ſoft plaſter; that it ſeparates into concentric plates, which are eaſily divided into a hundred; and that theſe plates are formedof fibres intertwiſted, or rolled up in ſpiral windings.

Chrouet, in his hiſtory of the humours of the eye, aſſures us that the cryſtalline affords oil and ammoniacal ſpirit in great abundance by the action of fire. Twenty-four grammes of this body diſtilled, afforded him two grammes and a quarter of inſipid water, eight grammes of ammoniacal water, a third of a gramme of concrete carbonate of ammonia, a little leſs than three grammes of very fetid oil, and eight grammes of coal, the incineration of which left a gramme and a half of aſhes without fixed ſalt or alkali.

The cryſtalline becomes opaque by coction in boiling water, by the action of the acids, and by alcohol. It ſeems to be formed of a thick, albuminous and concreſcible matter with a portion of gelatin. No exact analyſis has yet been made of it.

5. The tears are ſecreted by a conglomerate gland, ſituated in a depreſſion at the external and ſuperior angle of the orbit, and they are diſcharged by ſix or ſeven open ducts in the conjunction over the margin of the upper eyelid, whence they flow along the eye towards the puncta lacrymalia. They have not been the object of a connected ſeries of reſearches. They had been repreſented as a rather ſaline aqueous liquor, affording ſcarcely any reſiduum by evaporation ; and Pierre Petit, in his curious treatiſe on the tears, being intirely occupied with their origin and their relations with the paſſions, had ſcarcely ſaid any thing concerning their nature. The illuſtrious Haller complained of this want of facts in his great phyſiological work; he contented himſelf with quoting ſome rare examples of ſaline cryſtals which they had exhibited to Bruckman, of thoſe of an auſtere acid taſte, which Schaper had obſerved in an ophthalmia of the blood which frequently is mixed with them, of the ſweet quality which had been found in them in ſome diſeaſes. Several fortunate opportunities for procuring them having preſented themſelves to Citizen Vauquelin and myſelf, in 1791, we made them the particular object of our reſearches; and we have publiſhed upon the Analyſis of this humour, in the

Annales de Chemie, for Auguſt of the ſame year, a Memoir of which I am now about to preſent the reſults.

6. We procured tears in ſufficient abundance to be able to make them the ſubject of our experiments, either from perſons ſubject to weeping, who conſented to collect them in ſmall glaſs veſſels, or by cauſing them to flow in unuſual abundance, by means of mechanical irritation applied to the noſtrils, or by the effect of cold, which increaſes their diſcharge in ſome individuals. This humour is as clear as water, without ſmell, of a ſaline taſte, and of a weight little ſuperior to that of diſtilled water. It turns the paper tinged with mallows or violets green, without this colour being diſſipated in the air; a proof that it proceeds from the action of a fixed alkali. When heated, it preſents at its ſurface many permanent bubbles, like a mucous liquor; evaporated to dryneſs, it leaves at moſt 0,04 of a dry and yellowiſh reſiduum of an acrid taſte. In cloſe veſſels it affords much water, ſome traces of oil and of ammonia, and a very ſaline coal. The incineration of the product of the ſpontaneous evaporation exhibited to us muriate of ſoda, carbonate of ſoda, very little phoſphate of ſoda and phoſphate of lime.

7. Tears expoſed to hot and dry air, in a flat veſſel, become thick pretty quickly; they become viſcid and ſtringy, without loſing their tranſparency; aſſuming a yellowiſh and ſometimes

times a green colour. They afford cubic cryſtals, which alcohol diſſolves without attacking the mucous and thick part; theſe cryſtals turn paper ſtained with mallows green, and announce an exceſs of alkali. Water which diſſolves immediately, in every proportion, and dilutes the lacrymal humour in its natural ſtate, does not operate in the ſame manner upon this humour when thickened and become ſtringy by expoſure to the air. It remains ſuſpended in the water like a glairy matter, or elſe diſſolves very ſlowly; for the water froths by agitation, after having remained a long time upon this matter. This is an inſtance in which the contact of the air deprives an animal matter of its ſolubility in water.

The alkaline ſolutions, which have no ſenſible action upon the pure tears, quickly diſſolve tears that have been thickened by expoſure to the air, and reſtore them to their original fluidity and tranſparency.

Lime-water, the ſolutions of barites and of ſtrontian, produce no effect upon the tears at the moment of their diſcharge; but when they have been for ſome time expoſed to the air, they render theſe liquors turbid, and afford very ſenſible precipitates of earthy carbonates. This phenomenon proceeds from the circumſtance that the tears contain a ſmall quantity of pure ſoda, which attracting the atmoſpherical carbonic acid, and paſſing gradually by the contact of the air into the ſtate of alkaline carbonate, becomes

comes thus ſuſceptible of being decompoſed by the ſolutions of the three earths, whoſe attraction for carbonic acid is ſtronger than that of the ſoda. Alcohol forms very ſenſible white flakes in the tears, and retains the moſt of their ſalts in ſolution.

8. No acid has any action upon the tears at the moment of their diſcharge, when they have not yet experienced any alteration. No other change takes place in them, than the ſaturation of the ſoda which they contain: ſo that the ſmalleſt quantity of acid is ſufficient to prevent their turning the mallows-paper green. The reſiduum of their ſpontaneous evaporation comports itſelf differently with the acids. A drop of concentrated ſulphuric acid thrown upon this reſiduum produces a very ſenſible efferveſcence, accompanied with a white vapour; muriatic acid and carbonic acid are diſengaged at the ſame time, which announces the decompoſition of the muriate of ſoda contained in this fluid, and of the carbonate of ſoda which is formed in it by expoſure to the air. The muriate and acetous acids, on the contrary, produce only a ſlight effervеſcence with this ſpontaneous reſiduum of the tears, becauſe they decompoſe only the carbonate of ſoda, and diſengage only the carbonic acid.

9. The oxigenated muriatic acid is one of the re-agents that have given us the moſt light reſpecting the nature of the tears. We already

know from a fact, which cannot eſcape our obſervation in active laboratories, that the contact of the oxigenated muriatic gas thickens the lacrymal humours to ſuch a degree, as to render the motion of the eye-lids upon the ball of the eye difficult and painful. When liquid oxigenated muriatic acid is poured upon tears at the moment when they have been diſcharged from the eye, a ſlight coagulation takes place in this liquid; flakes are precipitated, at firſt white, which are quickly turned yellow by a larger proportion of acid. In proportion as they are formed, the oxigenated muriatic acid loſes its harſh ſmell; whence we ſee that it yields its oxigen to the animal matter. It cannot be doubted, that what here takes place rapidly, is effected in a gradual manner upon the tears by the contact of the air; that in both caſes the fixation of the atmoſpheric oxigen is alone to be conſidered as the cauſe of the thickening and the formation of a white and ſeemingly puriform matter, which takes place in the naſal ſac, when the tears remain in it, obſtructed by any impediment. A ſlight compreſſion, to the application of which perſons ſubject to obſtructions of this ſac are incited by an itching ſenſation, cauſes this thick yellowiſh matter to iſſue out from the puncta lacrymalia, in ſmall cylinders or elongated drops, more or leſs ſolid, moulded by the branches of the lacrymal ſyphons. We muſt add indeed to this action of the atmoſpheric oxigen, the evaporation of the water as a cauſe of this thickening; for we were convinced by a ſubject afflicted with an obſtruction of the naſal ſac, that he could extract four times as much humour from this diſtended ſac by preſſing it out every hour, than by ſoliciting its diſcharge every four hours. The ſame inſpiſſation, proceeding from the abſorption of the air by the tears and the evaporation of their water, gives riſe to thoſe ſmall clots of thick, yellowiſh, and concrete humour, which are formed during ſleep, round the lacrymal caruncles.

10. It reſults from this analyſis that the tears are formed of a large quantity of water, which holds in its ſolution an animal mucilage, not albuminous, becauſe the ſimple acids do not coagulate it, but of a gelatinous nature, and ſeveral ſaline ſubſtances, muriate of ſoda, pure ſoda, phoſphate of ſoda, and phoſphate of lime. The two laſt are leſs perceptible than the two firſt. One of the characters that moſt eminently diſtinguiſh this animal matter, is the property which it poſſeſſes of rapidly abſorbing oxigen, and of forming thick, concrete, inſoluble flakes. Though it contains the muriate and the phoſphate of ſoda in but ſmall quantity, the firſt is nevertheleſs ſufficient to give this humour a ſaline taſte, and enable it to depoſit ſome ſaline cryſtals on the outſide of its ducts, as ſome rare obſervations have ſhown.

The phoſphate of lime, of which we have found only ſome ſlight indications in the tears, may, it appears, increaſe in its proportion under certain circumſtances, and ſeparate in the ſolid form: it is this which gives riſe to the calculous concretions which are ſometimes formed in the lacrymal glands, and are even depoſited in ſmall ſeparate grains round this gland. I have twice had occaſion to analyſe this concretion, and have found its ſolid baſe to be calcareous phoſphate.

Article XV.

Of the Naſal Mucus

1. THE name of *naſal mucus*, is given to a liquid which is ſecreted in the cavities of the noſe, and is diſcharged outwardly, either by the noſtrils in the form of drops, or in that of maſſes more or leſs thick and viſcid, or by the fauces, when it deſcends by the poſterior part of the naſal cavities in which caſe it is thrown out by hawking and ſpitting. This liquid is ſeparated from the blood by the arteries, with which the whole ſchneiderian membrane is provided, and appears to be formed in particular glandular crypts, which we find abundantly diſſeminated in the noſtrils; it is collected alſo from all the frontal ſinuſes, from thoſe of the ethmoid, of the ſphenoid and of the ſuperior maxillary bones, upon the membraneous ſides

of which we ſee no glanduliform crypts. It is alſo mixed with the lacrymal juice, which deſcends by the channel which paſſes through the os unguis, and dilutes the thickened naſal mucus.

2. We muſt particularly conſider both the abundance and the characters of this liquid in the catarrh, improperly called catarrh of the brain, in which the naſal mucus is ſeparated in larger quantity, and remains a longer time in its ducts. It is eſpecially under this circumſtance that Citizen Vauquelin and myſelf have examined it, as we then procured it with great facility. We have alſo availed ourſelves of the conſiderable diſcharge of mucus which is produced by the contact of the oxigenated muriatic acid gas, in order to obtain a ſufficient quantity of it for the experiments adapted for making us well acquainted with its nature. It has ſeveral times happened to Citizen Vauquelin, who is very ſenſible to the action of the oxigenated muriatic acid gas, that he has collected by its effect ſixty-four grammes of this liquid in leſs than an hour. By means of theſe circumſtances we have been enabled to determine its nature in a conſiderably exact manner. It is known that this liquid is very abundant in children, that it is a little heavier than water, and adheres to moſt bodies, even the moſt poliſhed.

3. The naſal mucus is at firſt liquid, clear and limpid, a little viſcid and adheſive, without

ſmell, of a ſaline and acrid taſte, which irritates the moſt delicate part of the ſkin: it is then really the pituita vitrea of the ancients. When expoſed to the air and to the fire, it comports itſelf in the ſame manner as the tears, from which it differs only by the abundance of its reſiduum which is thicker, and frequently more coloured. It affords cryſtals of muriate of ſoda, of ſoda in the ſtate of carbonate and of phoſphates of lime and of ſoda; the laſt are much more abundant than the others. It turns paper ſtained with mallow-flowers green, by its ſalts; we alſo find in it an animal matter which is not albuminous, but quickly becomes thick and concrete by the oxigen of the air and of the oxigenated muriatic acid; it then acquires opacity, and a yellow or greeniſh colour, ſwells conſiderably, and becomes filled with bubbles by the action of fire, leaving but little reſiduum upon the ignited coals. This animal mucilage, which is more abundant than in the tears, appears to be of the ſame nature in both.

4. This liquid, being always expoſed to the air which continually paſſes through the noſtrils, is conſtantly thicker, more viſcid and more adheſive than the tears; and the carbonate of ſoda which it contains, whilſt the latter contain only ſoda, announces that the air depoſits in it a part of the carbonic acid which it contains, eſpecially as it is expired out of the lungs. Conſequently, it then renders the ſolutions of barites, of

ſtrontian, and of lime, very ſenſibly turbid. In the noſtrils, the heat of the plant, eſpecially in catarrhs, and the current of air which inceſſantly acts upon it, contribute alſo to thicken it. The mucilage of the naſal humour, when it becomes thick in the air, frequently aſſumes in it the form of ſmall, dry brilliant, and as it were, micaceous plates. If it has dried in very thin layers, it nearly reſembles thoſe brilliant and light marks which ſnails leave behind them upon the ſubſtances over which they crawl. The naſal mucus experiences no real putrefaction in the air; we ſhould almoſt be induced to ſay that it was unalterable and imputreſcible, when we ſee it remain without contracting any bad ſmell, even in the midſt of water, and at a conſiderably elevated temperature. However, this property of preſervation does not extend ſo far as to communicate itſelf to other bodies that are immerſed in it.

5. Water does not diſſolve the mucus of the noſe. It is known that this matter remains viſcid in that fluid, and that it cannot be diluted water without much difficulty, even by agitation. Hot water and ebullition do not render this ſingular mixture more miſcible or more ſoluble. In boiling water, it appears at firſt to form one body with the water; nevertheleſs we ſee it ſeparate and fall to the bottom of this liquid by cooling. It is probable that this inſolubility is owing to the fixation of the oxigen. Neither has it the property of ren-

dering oils miſcible with water, nor of effecting their ſuſpenſion by trituration, as a vegetable mucilage does. It is on this account that when we waſh, or even boil this thick humour in water, the ſalts which it contains are diſſolved and ſeparated, without affecting the mucilage which conſtitutes its baſe.

6. The acids thicken the naſal mucus when they are concentrated and employed in ſmall proportions; but when we add a larger quantity, they re-diſſolve and give it different ſhades of colour. The ſulphuric acid tinges it purple, and renders it very liquid, forming however ſome flakes in it which ſink to the bottom. The nitric acid, when rather ſtrong diſſolves it of a yellow colour. The muriatic acid is that which effects its ſolution the moſt eaſily and the moſt completely of all, giving it a violet colour. The alkaline or earthy ſalts do not cauſe it to undergo any alteration, nor do they diſſolve it.

7. The mucus of the noſtrils being eſpecially diſtinguiſhed from all the other animal liquids by the viſcid mucilage which it contains in conſiderable abundance, it is evidently from the preſence of this principle that we ought to ſeek its uſes and the function which it performs in the animal economy. Beſides the kind of evacuation, ſometimes very abundant, which it procures, and the proportion of the evacuated matter compared with that of the other excretory organs, which it carries out of the body, this

liquid maintains the ſoftneſs of the membranous ſides of the naſal cavities and prevents that dryneſs which the air paſſing in continual ſtreams through theſe cavities tends to produce in them. It moderates the too great ſenſibility of the nervous papillæ which are ſpread out upon the olfactory membrane; it ſtops and fixes the odorous bodies, it blunts their too great activity; it purifies the air that is reſpired, by taking from it the pulverulent particles which it carries along with it, and which would be more hurtful in the lungs. Being always contained in a hot humid, and arid place, three circumſtances which would ſo eminently promote putrefaction, provident nature has given it a property which oppoſes the ſepticity which would have expoſed man and the animals to a multitude of dangerous vitiations and maladies.

8. It is known that the mucus of the noſtrils is capable of changing its nature and aſſuming various properties in the naſal affections. It thickens, becomes yellow, orange-coloured, or greeniſh, frequently tinges linen with a very lively green caſt by drying upon it; it ſometimes produces the ſenſation of the preſence of copper; and ſometimes it exhales a nauſeous or fetid ſmell. In ſome affections it becomes ſo acrid that it ſeems to corrode the membrane of the noſtrils, and produces excorrations round their orifices as well as upon the upper lip. Laſtly, it is ſometimes liquid like water, at others ropy like oil; in ſeveral caſes thick,

viſcid, and always tranſparent like jelly; in other circumſtances, ſemi-concrete and white, yellow or green, like a purulent humour. None of theſe changes have yet been chemically examined, and hardly even has the attention which they deſerve been beſtowed upon them.

9. Citizen Vauquelin and myſelf have deſcribed with much care the effect which the oxigenated muriatic acid gas produces upon the naſal mucus and upon the membranes which it covers and from which it filtrates. At the very moment when this gas penetrates into the noſtrils, it produces in them a ſenſation of contraction and of uneaſineſs, of which ſneezing is the conſequence; a conſiderable diſcharge of clear liquid is excited. The contraction and the rigidity of the membranes of the noſe and of the throat remain for a long time: after the ceſſation or diminution of the firſt diſcharge, follows an uneaſineſs and ſtuffing of the noſe, and the ſenſes of ſmell and taſte are loſt. An humour, thick, and even dry like parchment, is felt in the noſe and in the fauces: an acrid heat propagates itſelf into the breaſt and produces a febrile commotion: a conſiderably violent head-ache, and confuſion of intellect accompany this ſtate. At laſt white or yellow concrete maſſes are diſcharged by the noſtrils or the mouth, the diſcharge of which laſts ſeveral hours, procures relief, and the malady gradually ceaſes till the equilibrium is intirely re-eſtabliſhed. It

cannot be doubted that this artificial diſeaſe has a great analogy with the natural catarrh, and that in the production of that diſeaſe the atmoſpheric oxigen exerts an action ſimilar (excepting that its intenſity is leſs) to that of the oxigenated muriatic acid. In the ſudden ſharp froſts which are perceived by a harſh rough ſenſation, this principle of the atmoſphere acts very quickly upon the naſal mucus; it thickens it by depriving it of water and becoming itſelf fixed; it irritates the ſurface of the ſchneiderian membrane; it evaporates, in the compound ratio of its motion and its denſity, a large quantity of water. This explanation of a natural fact, to which we have been conducted by a phenomenon created by art, ſhows what may be hoped from the reſearches of modern chemiſtry, and how important it is to purſue them without intermiſſion.

ARTICLE XVI.

Of the Mucous Humour of the Mouth, of the Humour of the Tonſils, of the Saliva, of the Salivary Calculus, and of the Tartar of the Teeth.

1. THE cavity of the mouth, from the margins of the lips to beyond the velum pendulum of the palate, and as far as the upper part of the pharynx, is conſtantly moiſtened by ſeveral liquids which have their ſource in different glandular and ſecretory organs, whoſe seat, form, ſtructure, excretory ducts and functions have much occupied anatomiſts and phyſiologiſts. Very numerous mucous crypts and granulated pellicles occupy the whole ſurface of the tongue, and eſpecially of the infralingual cavity, of the buccal and palatine membrane or of the glandular expanſion of Morgagni, of the alveolar arches, and pour into this cavity an humour ſomewhat leſs thick and mucous than that of the noſtrils, which maintains on all the ſides of the mouth a continual ſoftneſs and lubricity, adapted to facilitate their motion, to enable the alimentary bole to ſlide down, and to prevent that thirſt which dryneſs of theſe parts, from whatever cauſe it may ariſe, conſtantly produces. This kind of mucous and lubricating humour

have never been examined in particular, nor could it, either becauſe it is not ſufficiently abundant to be collected ſeparately, or becauſe it is always mixed with the ſalivary humour and the humour of the tonſils which inceſſantly flow into the mouth. For the reſt, it does not appear to be in any reſpect different from the humour which is ſecreted in all the cavities in order to lubricate them, and of which we have already treated.

2. The tonſils, organs very ſingular in their form and their fungous ſtructure, placed on both ſides of the throat before the paſſage of the alimentary bole, and between two membranous columns which ſupport the velum palati, inceſſantly diſcharge into the poſterior fauces, by the numerous crypts and pores with which their whole ſurface is covered, a ſomewhat thick and glairy humour, which is frequently ſeen about them when they are viewed with attention, and which we feel detach themſelves like ſmall gluey maſſes by the rapid motion which is communicated to the air in the action of hawking. It is believed that this humour, the quantity of which muſt be pretty conſiderable from the ſize of the organs which furniſh it, is of the ſame nature with that of the crypts, and that of the glands of the mouth. No particular examination however has been made of it, and we ſtill judge of it only by the analogy of its place of ſtructure and its uſes.

3. The ſaliva, properly ſo called, ſeparated from the blood in the parotids, the ſubmaxillary and ſublingual glands, poured into the mouth by the ducts of Stenon from the firſt, of Warthon from the ſecond, and of Rivinus from the third, has been, if not analyzed with much attention, at leaſt ſufficiently examined by Vieuſſens, Pott, Nuck, Barchuſen, Verheyen, Boerhaave, and Haller, to be better known than the preceding liquids. Haller, in his great phyſiological work, has collected all that phyſiologiſts had obſerved before him. I have added ſome facts to thoſe which had been indicated by the authors abovementioned. Citizen Michel de Tennetar has deſcribed ſome phenomena which this humour preſents in acting upon the metallic ſubſtances. Citizen Lachenaye has given a ſufficiently detailed analyſis of the ſaliva of the horſe; but none of theſe chemiſts has announced more experiments, or a more concluſive ſeries of inquiries, than M. Siebold, who publiſhed, in 1797, at Jena, a ſufficiently detailed diſſertation in quarto, upon the ſalivary ſyſtem, conſidered in a phyſiological and pathological point of view. I ſhall borrow from theſe different authors, as well as from my own obſervations, what I am about to ſay concerning this humour.

4. The ſaliva is a ſlightly viſcous liquid, ſtrongly characterized by its frothy ſtate, its inſipid and partly ſaline taſte, its want of ſmell, its

ſweetiſh odour, and its white colour mixed with a blueiſh caſt. Its weight is to that of water, according to Haller, as 1960 to 1875, and according to Mr. Siebold, as 1080 to 1000. The proportion of its conſiſtence, or of the coheſion of its molecules to that of water, as 30 to 10. Mr. Siebold, in order to define this conſiſtence in a more perſpicuous manner, ſays that it reſembles a mixture of one part of gum and forty parts of water. It is neither acid nor alkaline: it does not change the natural ſtate of any vegetable colour. Brugnatelli aſſerts, that he has found it impregnated with a large quantity of oxalic acid in an emaciated venereal patient, who appeared to him to loſe, by this evacuation, the nutritive and ſaccharine part of his aliment. Its quantity varies greatly. Nuck eſtimates it between 256 and 384 grammes in twenty-four hours. In exceſſive ſalivations, its diſcharge has been to the amount of two or three kilogrammes daily: Turner eſtimates its whole quantity, diſcharged during an entire mercurial courſe, at 60 kilogrammes or 120 pounds. Some authors have aſſerted that the ſaliva carried mercury along with it; but it has never been practicable to extract any from it in the experiments made in the laboratory of the Ecole de Medicine of Paris.

5. The ſaliva, heated or evaporated, leaves but very little reſidue; it ſwells conſiderably, and ſoon dries into ſmall white or yellowiſh, ſaline and acrid plates. When it is evaporated

to a third of its quantity, and afterwards ſuffered to cool and repoſe, it affords cryſtals eaſily diſtinguiſhable as muriate of ſoda, by their cubical form, their ſaline taſte, the muriatic acid vapour which the ſulphuric acid diſengages from them, and the curdled precipitate which they form in the nitrate of mercury. Gently evaporated to dryneſs, the ſaliva leaves a reſiduum like the glutinous matter of flour, which ſwells and inflames upon the coals, exhaling a ſmell of burned horn or hair. A ſmell of Pruſſic acid is alſo perceived. When the ſaliva is ſubjected to diſtillation in a glaſs retort, we ſee a froth ariſe upon it, which occupies a large ſpace; it affords all the products of the animal matters, and leaves a coal in which I have found, beſides the muriate of ſoda, phoſphates of ſoda and lime in conſiderable abundance. Pruſſic acid is alſo very perceptible amongſt the products. The proportion of ammonia formed is not larger than in the diſtillation of the other animal matters.

6. When expoſed to the air, the ſaliva abſorbs a conſiderable quantity, and froths much by agitation; at the end of ſome hours, according to the obſervation of Mr. Siebold, it preſents a light pellicle, exhibiting the priſmatic colours, and of a fatty appearance at the ſurface; it ſoon becomes turbid, and depoſits flakes; it exhales a very lively and very pure ammoniacal odour. Macbride believed that there eſcaped from it a large quantity of fixed

air: this he particularly concluded from the large volume and the frothy ſtate which it aſſumes in vacuo: it is well known that it is ordinary air which is diſengaged in this experiment. The ſaliva putrefies and becomes very fetid after the ammonia which has formed in it has been diſengaged. This humour, however, has been conſidered, according to the experiments of Pringle, as eminently antiſeptic, and it has been pretended that it checks the putrefaction of meat immerſed in it. Indeed, a greater number of authors have on the contrary ranked it amongſt the moſt powerful ferments, and have particularly deſignated it as promoting the vinous fermentation of the farinaceous ſubſtances; they have even thus explained how the ſavage nations of America and Africa prepare intoxicating liquors with maſticated roots and ſeeds, which they afterwards expoſe to fermentation. This property deſerves ſtill to be better aſcertained by accurate experiments.

7. The ſaliva has long been known to corrode or oxidate iron and copper pretty quickly. It was alſo cuſtomary, in the laboratories of pharmacy, to ſpit in the mortars in which the mercurial ointment was prepared, and it was known that this proceſs accelerated the extinction or the black oxidation of the mercury. Citizen Michel du Tennetar, profeſſor of chemiſtry at Metz, diſcovered, about twelve years ago, that when leaf-gold and leaf-ſilver were triturated

in ſaliva, the oxidation of both theſe metals, which are ſo difficult to be burned, was effected. It appears that it is ſtill more eaſy to oxide mercury by itſelf in this animal liquor, from a method which has been long practiſed by the Engliſh ſailors, and which conſiſts, according to what I have heard from able phyſicians of that nation, in kneading ſome globules of mercury in the hollow of the hand with the aid of ſaliva, and immediately taking the mercury thus extinguiſhed. By rubbing mercury in ſmall globules adhering to the fingers greaſed, upon the inſide of the cheeks, and as in the method of Clarke, venereal ſymptoms are cured: all theſe phenomena depend upon the ſame cauſe.

8. The ſaliva mixes but imperfectly, and does not completely diſſolve in water; it ſwims at its ſurface, and remains well ſeparated from it. This effect has been attributed to its viſcidity and ſluggiſhneſs; to which we muſt add the little ſoluble nature of the animal mucilage contained in this liquor. Ebullition of the water coagulates ſome flakes in it, and retains the ſaline matters, which it ſeparates from it. The ſtrong acids, in ſmall doſes, thicken the ſaliva, as we perceive in the mouth when we hold an acid liquor in it; in larger doſes they diſſolve it. The fixed alkalies and the earths immediately diſengage ammonia from it. Lime-water, and the ſolution of barites form a precipitate of phoſphate of lime in it; the oxalic acid

ſhows the preſence of lime by the precipitate which it produces, though it be very ſlight. The metallic ſolutions, eſpecially the nitrates of lead, of mercury, and of ſilver, render the ſaliva very turbid, and produce an abundant precipitate in it; it was eſpecially by theſe means that I found the phoſphates that exiſt in this animal liquid; for theſe metallic precipitates afford very ſenſible traces of muriatic acid and phoſphoric acid both at the ſame time.

9. From all the facts here enunciated it follows that in man, the ſaliva is formed of a quantity of water, which is eſtimated at $\frac{5}{4}$ or $\frac{4}{5}$ of a highly aërated animal mucilage, frothy, almoſt inſoluble or very little ſoluble in water, or of a ſmall proportion of albumen and of ſaline matters, which are muriate and phoſphate of ſoda, ammonia and lime. This manner of conceiving the compoſition of this liquid, beſides that it is the reſult of the experiments hitherto made upon its nature, explains alſo all the phenomena which the ſaliva preſents, its ſemi-coagulation by fire, by the acids, and by alcohol; its difficult ſolution in water, the light flakes which it affords in many caſes, its ſluggiſh viſcidity, its frothy property, and its precipitation by a multitude of bodies. The ſaliva muſt be conſidered as a condenſed ſolution of this viſcid mucilage, which very readily detains the air into which it is immerſed, to carry it into the alimentary bile, and into the ſtomach. The ſalts which it con-

tains may vary in their proportions, and actually do vary, according to a multitude of circumſtances.

10. It frequently happens that there are formed in the ſtrainers of the ſaliva, and depoſited in the excretory ducts of the ſalivary glands, ſome kinds of concretions or calculi, which have been improperly called ſtones. They have been particularly obſerved in the Warthonian duct much more frequently than in the Stenonian, or that of Rivinus. Haller, after having quoted a multitude of examples from authors, inquires what may be the cauſe that favours this formation in the firſt claſs of theſe ducts rather than in the two others. We are not ſufficiently acquainted with the ſtructure of the different ſalivary glands to be able to pronounce upon the cauſe of this ſingular prerogative of the Warthonian duct. Scherer, in a diſſertation intituled *De calculo in ductu ſalivali*, has deſcribed with great care the maladies which this ſpecies of concretion produces, and all the circumſtances which accompany it. Hippocrates was already acquainted with the ſtone under the tongue. The tumor called *ranula*, and *anginas*, have been known to be the conſequences of this kind of concretion. Many facts have alſo proved that it is ſpeedily formed. I have examined one of theſe ſalivary calculi given me by Citizen Sabbatier, and I found it to be compoſed of phoſphate of lime and of a kind of animal mucilage. Its ſource

is therefore manifeſtly in the ſaliva, which, like all the white and more or leſs viſcid humours, contains phoſphate of lime, the proportion of which is ſometimes augmented by cauſes that are hitherto unknown or undetermined. It appears that this augmentation depends, in ſeveral circumſtances, upon a general cauſe, and that it takes place in all the humours at the ſame time, undoubtedly becauſe the ducts which naturally evacuated its ſuperabundance are then too much conſtricted. In ſuch caſe, ſimilar concretions are formed in many places, and ſome are depoſited even in the ſubſtance of the membranes.

11. Thoſe very frequent incruſtations which ſurround the baſe of the teeth, and are known by the name of tartar, which looſen and repel them, deſtroy the gums, and ſometimes become ſo conſiderable that they ſeparate and diſplace the teeth themſelves in ſome individuals who take no care of their mouths, are alſo of the ſame nature. The ſaliva, and the other juices of the mouth which inceſſantly bathe theſe bones, and remain between the margins of the gums and the teeth, gradually depoſit upon them, by a real cryſtallization, particles of this earthy ſalt; and it is not to the reſidue of the aliments, as is commonly believed, that this pretended *tartar of the teeth* is to be attributed. When we examine with a good magnifying glaſs the tartariform concretion which encircles theſe bones towards their

baſe, and which ſometimes extends as far as their alveolae to the ſides of which it attaches itſelf, we find it compoſed of ſmall grains united together and brilliant in ſome points. We perceive in it, by the microſcope, a great number of pores or ſmall polyhedral cavities which reſemble the cells of polypuſes in their form and arrangement. Magellan, the philoſopher who undoubtedly ſaw microſcopic animalcul in it, thought that this concretion was a ſort of nidus of *polypuſes* formed by theſe animals. But it is more natural to believe, that this cryſtalline depoſition of the humours of the fauces, ſimilar to the concretions ſo generally diffuſed and ſo common in the animal economy, receives at its ſurface and in its pores ſome particles of alimentary reſidue, charged, like every ſoft, humid, and warm organic matter, with microſcopic animalcul. The nature of this depoſition upon the teeth is really phoſphate of lime, mixed with a portion of mucous and glairy ſubſtance: accordingly, the acids diſſolve it, as has long been known, by the employment of theſe ſubſtances adapted for cleaning the teeth, upon which indeed the acids act in a dangerous manner if care be not taken to confine their operation merely to the layer of tartar which ſurrounds and covers them.

ARTICLE XVII.

Of the Cerumen of the Ears.

1. THE cerumen of the ears, ſo called on account of the conſiſtence of ſoft wax which it commonly has, attracted the attention of the ancient phyſicians much more than of thoſe of the preſent age. The ancient ſchools, as Bourdeu has obſerved, taught that the gall-bladder was purged of this humour of the ears. Hippocrates aſſiduouſly occupied himſelf with the conſideration of it in diſeaſes, and compared its production with the flow of the bile: the moderns have intirely neglected this kind of obſervations; and at the preſent day the analogy, which ſubſiſts between this humour and that ſecreted by the liver, ſeems forgotten. The cerumen, however, poſſeſſes properties ſo remarkable, ſo different from thoſe of moſt of the other animal liquids, that I have thought I ought to aſſign to it a particular article. What does not appear ſtriking to every one at preſent may appear ſo hereafter. This aſſertion is particularly applicable to the matter which forms the ſubject of the preſent article, and of which but very little has been ſaid by any author, even amongſt thoſe who have particularly occupied themſelves with the organ of hearing,

Caſſebohm, Valſalva, Duverney, Schroeder, Le Cat, &c. Haller, who according to the order which he had adopted, exhibits by his vaſt erudition all that the anatomiſts and phyſiologiſts had diſcovered before him, has ſcarcely devoted five or ſix lines to the examination of the diſtinctive properties of the cerumenous humour.

2. This humour is prepared in a particular glandular apparatus diſcovered by Stenon, ſeen by Drelincourt, well deſcribed by Valſalva, Duverney, and Haller. It conſiſts of ſmall round and oval glands, of a browniſh yellow colour, of a very firm conſiſtence, diſſeminated under the ſkin, and placed, either in the excavations of the oſſeous auditory paſſage, or in the cartilagineous portion of this paſſage, eſpecially towards its anterior part. Each of theſe ſmall glands has a very ſhort cylindrical duct, which perforates the epidermis, and opens into the auditory paſſage by an orifice viſible to the naked eye. There runs out from it a ſmall drop of a yellow humour, at firſt a little viſcid like an oil, which quickly thickens in the warm cavity of the ear by the contact of the air, and is converted into a kind of unguentaceous matter, of a deep yellow or orange colour, or even reddiſh, of a very bitter taſte, which inflames when it is heated, as Boerhaave had eſpecially indicated. Pechlin has compared the cerumen to caſtoreum. It had eſpecially been remarked that this humour might, by remaining

for a long time in the auditory paſſage, thicken in ſuch a manner as to form a ſolid cylinder, capable of obſtructing the paſſage like a real ſtopper, and prevent ſounds from arriving within it; that this thickening, which ſome authors have obſerved as far as concrete and plaſter-like ſtate, was a frequent cauſe of deafneſs, and that it was cured by injecting ſoap-water.

3. Theſe facts comprehend, even in the moſt learned and extenſive works, the whole hiſtory of the cerumen of the ears. Bordeu, who in many parts of the art, wiſhed to revive the notions of the ancient phyſicians, and eſpecially thoſe of the Coan ſchool, contented himſelf with prognoſticating, after having noticed the attention which this ſchool paid to the cerumen, that ſome practitioner might meet with a particular caſe adapted to explain the pretenſion of one of the ancients with reſpect to this ſubject. Nearly thirty years have elapſed during which this ſuggeſtion of an enlightened man has called in vain for obſervations. Whilſt I indulge the hope that phyſicians may beſtow upon the ſubject the attention which it deſerves, I ſhall exhibit ſome ideas reſpecting the chemical properties of this humour, which is difficult to be procured in the abundance requiſite for ſubjecting it to extenſive reſearches. I muſt ſay, that of all the phyſicians whom I have acquainted with the importance which I attach to the examination of this humour, my col-

league Hallé was the perſon who was moſt ſtruck with it, and that he ſucceeded, by his enlightened zeal for the progreſs of our art, in furniſhing Citizen Vauquelin and myſelf with a ſufficient quantity of cerumen to enable us to begin an exact analyſis of it.

4. The cerumen collected during ſeveral ſucceſſive months by a healthy individual, with the aid of an ivory ear-ſpoon, and kept in a piece of paper, impregnates the texture of the paper like a fat oil rendering it tranſparent, and preventing water from penetrating it. It is eaſy to be united and kneaded into a ſingle maſs; I have formed an almoſt ſolid ball of it, which was of an orange-yellow colour, nearly without ſmell, of the conſiſtence of ſoft wax, and of a bitter, diſagreeable taſte. When placed upon an ignited coal, the cerumen inſtantaneouſly melts; it quickly ſwells and exhales a thick fume, the ſmell of which is ammoniacal, and of a ſenſibly aromatic fetidity; it does not differ much from that of burned horn or hair; it emits very little flame at the end of this operation. It leaves a coal, which has loſt the pretty conſiderable volume which this matter had at firſt aſſumed, and which is too little abundant to be analyſed: this coal is difficult to be incinerated. We had too ſmall a quantity of cerumen to be able to diſtil it, eſpecially after to the little light which this experiment promiſes.

5. The cerumen triturated with water, in a mortar, dilutes pretty well and diſſolves in part. It affords a kind of emulſive liquor, of a yellowiſh white colour, in which we ſee ſmall drops of oil collect at the ſurface. This is manifeſtly the effect of a mucilage holding for ſome time an oil in ſuſpenſion. The matter thus diluted is ſuſceptible of the putrid decompoſition, though the intire cerumen keeps for whole years without any ſign of putrefaction; it is, next to the ſolid or oſſeous parts, the leaſt alterable of the animal matters. Alcohol takes up but very little from it, and is only ſlightly coloured, even when it is boiled for ſome time upon the cerumen: when this coloured alcohol is filtrated and left to cool, a portion of the matter which it had diſſolved is ſeparated ſo that the liquid becomes turbid and ſlightly milky. According to the compariſon of this action of water and of alcohol, the cerumen appeared to us to be an intimate mixture of an animal mucous ſubſtance with an oily or fatty matter, rendered concrete by the abſorption of atmoſpheric oxigen. This laſt matter renders it ſimilar to the bile, to which the ancients had already found it to be analogous.

6. Thus much I, for my own part, was able to aſcertain reſpecting the cerumen, from the ſmall quantity which I had collected from myſelf. Since theſe firſt experiments, Citizen Vauquelin, who had undertaken to examine the cerumen with which our colleague, Citizen

Hallé, had furniſhed us, and who having a much larger quantity of it, was able to ſubject it to a more regular ſeries of experiments, gave me reports of them, of which I ſhall here exhibit a ſketch, as it is adapted to extend the notions which I have already given, and to give them ſtill greater preciſion.

The maſs which he had to examine formed a ball, ſome centimetres in diameter, and nearly ſix grammes in weight. This matter is pitchy, of a bitter taſte, of a deep orange colour: put upon a piece of paper and ſlightly heated, it melts, penetrates, and ſpots this texture, rendering it tranſparent, as oil does. It has a very particular, ſlightly aromatic, and ſomewhat acrid ſmell, eſpecially when it is heated and rubbed between the hands.

7. Placed upon an ignited coal, the cerumen ſoftens, and exhales a white fume, which has the ſmell of burned fat; it ſoon melts, ſwells, becomes coloured, and emits an ammoniacal and empyreumatic ſmell. After this action of the fire, there remains a voluminous and rather light coal. Diluted with water, the cerumen forms a kind of emulſion of a yellowiſh white colour, which quickly putrefies and becomes very fetid. Though water does not diſſolve it, it however takes ſomething from it; for, in putrefying, it depoſits whitiſh and mucilaginous flakes. Treated with alcohol, with the aſſiſtance of heat, it communicates to it a ſaffron-yellow colour, and by cooling, ſome white flakes are

depoſited.

depoſited. Sulphuric ether alſo diſſolves part of the cerumen; and though it depoſits nothing by cooling, it acquires a ſlight colour by remaining ſome inſtants in contact with it, either in the heat or in the cold.

8. Two grammes of cerumen treated with hot alcohol loſt 1,25 grammes, and afterwards weighed only 0,75 of a gramme. The portion not diſſolved, when dried in the air, was tranſparent, brittle, leſs coloured, leſs fuſible by the fire, and exhaled, while it burned more ammonia than oily vapour; the coloured alcohol afforded by evaporation a reſiduum of a pretty dark colour, conſiderably bitter, of a conſiſtence and ſmell reſembling thoſe of turpentine, fuſible without ſwelling, volatilizing into a white vapour of a fatty ſmell, and without leaving any perceptible coal: it had all the characters of a fixed oil.

Two grammes of the ſame cerumen, treated with ſulphuric ether, with the application of a little heat, loſt 1,25 grammes, and weighed now only 0,95. The liquor was leſs coloured than that of the alcohol; evaporated by a mild fire, it left a matter of a pale-yellow colour, of a tenacious conſiſtence like turpentine, of a ſmell analogous to that of this reſin, and leſs bitter than that which had been obtained by the alcohol. The 0,95 grammes not diſſolved by the ether, reſembled the reſiduum left by the alcohol, and exhaled much ammonia upon ignited coals. There is, therefore, a ſtriking reſemblance between the action of alcohol and that of ether upon the cerumen: both take from it a matter of an oily nature, more ſoluble in the firſt than in the ſecond of theſe liquids, and leave an inſoluble animal ſubſtance.

9. The kind of fatty oil ſeparated from the cerumen by the alcoholic liquids, is fuſible, and diffues upon the coals a pungent adipoſe ſmell; a little coloured, and it is ſuſceptible of diſſolving in the fixed and volatile oils, but with difficulty in cold alcohol; though very completely if we employ a large quantity of this liquid. The leys of fixed alkalies unite with it by mere trituration, and form with it a kind of ſoap, which does not, indeed, aſſume either the taſte or the conſiſtence of common ſoap.

As to the matter inſoluble both in alcohol and in ether, ſince it becomes dry and brittle in the air, ſince it ſoftens and even partially diſſolves in water, which afterwards putrefies; ſince it is capable of exhaling empyreumatic ammoniacal fumes whilſt it ſwells upon the coals, and of diſſolving, though imperfectly in the alkalies, theſe characters manifeſtly belong to albumen; and what confirms this notion is, that when it is burned in a crucible of platina, it leaves a light coal of an acrid and alkaline taſte, manifeſtly containing ſoda and phoſphate of lime.

10. Beſides theſe two ſubſtances, the baſes of the cerumen of the ears, it manifeſtly contains a diſtinct colouring matter, though it has not

yet been obtained ſeparate, on account of the too ſmall quantity which we have hitherto had of this animal product. It appears that this colouring matter is the cauſe of its bitterneſs, and that it is the principle of the cerumen which varies the moſt, ſince in fact the moſt ſtriking differences which are remarked in it relate to its colouration and its bitterneſs.

Citizen Vauquelin has given the following reſult of this maſs. The cerumen of the ears is a compound of three ſubſtances: 1ſt. a fatty oil, more analogous to that which is contained in the bile, than to any other adipoſe animal matter; 2d. an albuminous animal mucilage; 3d. a colouring matter which ſeems to reſemble that which forms part of the bile, by its bitterneſs and its adheſion with the fatty matter.

11. The uſes aſcribed to the cerumen are, to ſoften and lubricate the ſides of the meatus auditorius, to deter inſects from entering into this paſſage, by its bitterneſs, to ſoften and even deaden the ſonorous vibrations of the air, and thus to moderate the force of ſound. There is reaſon to believe, from the oily nature of the cerumen, and its bitterneſs, that it ought to be ranked in the claſs of excretions, and that it evacuates a particular acrid matter. If, as the ancients remarked, its quantity increaſes in ſome circumſtances of diſeaſes, and if its proportion anſwers to that of ſome other evacuations, the obſervations which Bordeu called upon the phyſicians to make, may ſome day

afford more light reſpecting the uſes of this humour. Haller does not forget to remark, according to Derham, that birds have no cerumen, and that it is found only in thoſe animals whoſe meatus auditorius is more or leſs elongated. In fact, it is abundant in ſome of the mammalia; and it would be of great utility to the art to examine it with care in theſe animals, in order to aſcertain its properties and the relations or differences which ſubſiſt between it and that of man.

ARTICLE XVIII.

Of the Tracheal and Bronchial Humour; of the Pulmonary Gas, and of the calculous Concretions of the Lungs.

1. BY referring to this article, all the animal matters which belong to the cheſt in particular, and which are ſituated within the cavity of the thorax, we find a much greater number of theſe matters than I have inſerted in this title. In fact, we muſt rank in this claſs the tracheal humours, the humour of the bronchial glands, the arterial and the venous blood, the air inſpired, the air expired, or the pulmonary gas, the pulmonary tranſpiration, the humour of the pericardium, that of the pleura, the concretions of the lungs, the parenchyma-

tous texture of this viſcus, and the texture of the heart. But amongſt theſe twelve ſubſtances, there are many which are already known, and which have already been treated of in the articles concerning the matters generally diffuſed throughout the whole body. In fact, I have elſewhere ſhown the difference between the pulmonary, arterial and venous blood, and the blood of the other regions. The air inſpired is that of the atmoſphere, which has been examined in detail in the ſecond ſection; the pulmonary tranſpiration has been compared, in one of the preceding articles, with the cutaneous perſpiration of the whole body; the humour of the pericardium and that of the pleura preſent no difference from that of the other internal membranous ſurface; the parenchymatous texture of the lungs, which has been confounded with the cellular texture, has not yet been particularly examined; that of the heart is only muſcular fibre, more denſe than that of moſt of the muſcles. There are therefore to be examined with more detail, only the tracheal and the bronchial humours, the pulmonary gas, or the air evacuated by expiration, and the calculous concretions. I have not even comprehended, in this general enumeration, the humour of the thymus; becauſe, excepting that it has been compared with milk on account of its whiteneſs, its nature is abſolutely unknown. Not the ſlighteſt experiment has been made upon its compoſition and its properties, though this object is very intereſting, and deſerves all the attention of phyſiologiſts.

2. The larynx and the trachea are continually lubricated and moiſtened by a humour which extends throughout the whole continuity of the bronchial, and which covers, lubricates, and ſoftens their internal membrane. This humour is a little viſcous and gluey; it is tranſparent, and of ſuch a conſiſtence, that it cannot flow; for, had it this character, it would inceſſantly irritate this very delicately ſenſible paſſage, and excite a perpetual cough. This humour of the trachea appears to be of the ſame nature as that which moiſtens and lubricates all the other cavities or hollow membranes. It is, however, probable, that this liquid has not the ſame ſaline character as the ſaliva, the mucous humour of the mouth, &c. It is known that the tracheal humour has neither taſte nor ſmell. Hitherto it has not been poſſible to make any particular analyſis of it, becauſe it is not eaſy to procure a ſufficient quantity of it for this analyſis. Anatomiſts have attributed the origin and referred the ſource of this liquid to mucous glands or crypts, ſituated under the internal membrane of theſe air ducts; ſometimes it is diſcharged in the form of ſputa. It cannot be doubted that, being inceſſantly in contact with the air which penetrates the bronchial veſicles, this humour thickens, either by the evaporation which it undergoes, or by the action which the atmoſperical oxigen gas exer-

ciſes upon it. Some phyſiologiſts have erroneouſly attributed to it the blackiſh blue colour, of certain flaky matters which are coughed up, and which proceed from another ſource, of which I ſhall ſpeak in the following number.

3. The tracheal humour is conſidered as adapted to prevent the dryneſs of the internal ſurface of the larynx, of the trachea, and of the bronchia, a dryneſs which would eaſily be occaſioned by the contact of the air, that continually paſſes through theſe cavities. It is alſo believed, that it defends the membrane of theſe very ſenſible paſſages againſt the action of different acrid ſubſtances and irritating powders, ſo often diſſeminated in the air which inceſſantly traverſes them; finally, the uſe is attributed to it of rendering the voice ſoft, and preventing the roughneſs and hardneſs which the ſounds iſſuing from the lungs would have, if theſe tubes were dry and deſtitute of this lubricating mucilage. The air which deſcends very dry and very cold into the lungs, takes away much of the evaporable or aqueous part of this tracheal humour, and gives it a remarkable character of glutinoſity and adheſion to the ſides of the trachea; in this caſe this thickened matter, which can no longer be eaſily abſorbed, is diſcharged by the cough which its weight and its irritation excite: ſuch is the cauſe and the nature of catarrhs. The glairy laminæ, or the more or leſs concrete flakes, are ſeparated only by a violent effort of

the air which impels them, and then the cough is convulſive or painful; or elſe they are raiſed or ſlowly detached from above the tracheal membrane, by this liquid humour which exudes beneath them, in which caſe they are coughed up with more facility and leſs pain. It is in this manner that confinement to the bed, by retaining the perſpirable matter in its veſſels, and cauſing that of the lungs to be more abundant, operates.

4. I diſtinguiſh by the name of *bronchial humour*, a kind of matter ſeparated by the glands of the ſame name, which is poured into the bronchia by particular ſmall excretory ducts. It is very different from the tracheal humour; it is not viſcid, ropy, nor extenſible like that matter. It is diſcharged in the morning in the form of ſmall, irregular, and moſt frequently roundiſh lumps, of a conſiſtence reſembling a thick jelly, of a blackiſh or blueiſh colour, inſoluble in water, at the ſurface of which they ſwim; its quantity varies in different individuals. Though it has not yet been particularly examined, its ſenſible characters are ſufficient to diſtinguiſh it as a peculiar matter. The glands which furniſh it, and which have not yet perhaps ſufficiently fixed the attention of anatomiſts or phyſicians, have themſelves a ſtructure very diſtinct from all the other glandular organs. They have been erroneouſly confounded with the ſyſtem of lymphatic glands. Their form, their ſize, their texture,

their colour, even their conſiſtence, and their diſeaſes, every circumſtance claims the attention of ſcientific men to this organ hitherto too little known. We might be induced to ſuppoſe, when we obſerve their blueiſh or blackiſh grey colour, their conſiſtence, and that of the humour which they furniſh, that they form a kind of reſervoir for the carbonous matter of the blood. Many obſervations, followed up with zeal and ſagacity, are required in order to determine the uſes and the functions of this particular glandular ſyſtem.

5. By calling the elaſtic fluid which is diſcharged from the lungs by expiration *pulmonary gas*, my intention is to announce that the atmoſperic air, after having remained for ſome time in the lungs, is diſcharged from them in a ſtate of alteration which depends upon the nature of this organ itſelf, and which I have already indicated in the hiſtory of the blood. This fluid is nearly the ſame in quantity as it entered, ſince the carbon and the hidrogen, as well as the water ready formed, which are added to it, correſpond very nearly with the proportion of oxigen gas which it yields to the blood. It contains no more than a few hundredths of this oxigen gas; and if it has been reſpired two or three times in ſucceſſion, which cannot be done without much difficulty, it contains none at all: accordingly, it extinguiſhes inflamed bodies, and ſtupefies animals. We find in it the ſame proportion of azotic gas

as before. Water is one of the materials that are added in the greateſt abundance to this expired gas, ſince nearly half a gramme of it is expired every minute, or 720 grammes in 24 hours. We alſo find in it gaſeous carbonic acid, proved by the precipitate formed by the expired air when received into ſolutions of lime, of ſtrontian and of barites; it is alſo charged with more caloric than it contained when it entered the lungs: and this is the reaſon why it depoſits water in the form of fumes when it paſſes into a cold atmoſphere. Perhaps it may alſo contain a certain portion of carbonated hidrogen; and we may attribute to this ſubſtance, which has not been rendered ſenſible in it by chemical experiments, the dangerous and deadly effects which it produces, and which are different from the aſphyxia; perhaps ſome animal miaſma, ſome contagious virus may eſcape at the ſame time with the air expired. As it has not yet been exhibited by experiment, it is only by conjecture that we may ſuſpect its influence in the production of diſeaſes, and the ſepticity which it introduces into the humours of thoſe who reſpire it. Chemiſtry ought to occupy itſelf without intermiſſion in confirming or overturning theſe ideas, and rank them amongſt thoſe phyſical truths, the proofs of which medicine muſt either confirm, or elſe arrange them in the claſs of hypotheſes; in fact, theſe are adopted in the theory of this important art only for want of exact experiments and facts.

6. One of the matters peculiar to the organs contained in the thorax, and which is only the product of a morbid alteration, but more frequent than has hitherto been believed or aſſerted, is a concretion formed in the lungs, which has been called *pulmonary ſtones*, or *calculi:* theſe are ſmall, hard, unequal and rough bodies, of an irregularly ſpherical form, reſembling ſmall pebbles, of a grey or reddiſh colour, which becomes white when they are dried in the air, and which are diſcharged by coughing, ſometimes even whilſt the perſon is in perfect health, but moſt frequently in the courſe of ſome attacks of aſthma, or of the terrible phthiſis pulmonalis. Attentive phyſicians and exact obſervers frequently meet with them in their practice. Through their care I have had a ſufficient quantity of them to be able to examine them: I have found them to be of the ſame nature with the pineal, lacrymal, and ſalivary concretions: they are compoſed of phoſphate of lime, and of a ſmall quantity of gelatinous matter. It is not known whether they proceed from the texture of the lungs or bronchia itſelf, when the patients diſcharge them; but diſſections prove that they are formed in the areolæ even of the parenchyma of the lungs, ſince in cutting the lungs a great quantity of them are ſometimes found, which grate under the ſcalpel. Here, as in many

caſes already mentioned, this phoſphate of lime depoſited by its ſuperabundance proceeds from the white humours, when the concretion is ſmall and inſulated: but it may proceed alſo from the blood, eſpecially, when, being numerous and diſſeminated in the interior of the organs of reſpiration, theſe concretions appear to occupy at the ſame time the whole texture of the lungs.

ARTICLE XIX.

Of Milk and its different, economical, chemical, alimentary, and medicinal Properties.

SECTION I.

Natural History, or Formation of Milk.

1. MILK, a liquid ſo well known, ſo uſeful, ſo generally employed as food and condiment, is one of the ſubſtances which have been moſt examined by chemiſts, as it is one upon which the proceſſes of the arts have been extremely varied. Its hiſtory muſt be one of the moſt detailed, as it is one of the moſt important matters with which chemiſtry can be occupied: accordingly, we ſhall divide this article into eight paragraphs, in order to diſpoſe in a methodical order, adapted for facilitating its ſtudy, the facts which will lead us to

underſtand its properties. The firſt paragraph will contain an account of its formation; the ſecond, that of its chemical properties; the third, the chemical examination of the entire milk, ſuch as nature preſents it when it iſſues out of its reſervoirs; in the fourth I ſhall treat of the whey; in the fifth of the caſeous part, or cheeſe; in the ſixth of the butter or its oily matter; the ſeventh will be aſſigned to the examination of the principal differences which this liquid preſents in the ſpecies of animals which furniſh it; finally, the eighth will contain the enumeration of the various uſes for which different kinds of milk are employed in rude or civilized ſociety. As milk is one of the liquids with which Nature has ſupplied the firſt wants of men, it is not to be wondered at that an immenſe number of obſervations have been collected reſpecting its properties, and that its hiſtory, when we conſider it ſucceſſively as naturaliſts, as phyſicians, as chemiſts, or as economiſts, preſents very extenſive details.

2. This liquid is formed in a particular organ which occupies the anterior part of the cheſt, in women, and a large part of the abdomen in the female animals. As there are only a ſmall number of ſpecies of animals in which this formation takes place, and as theſe animals are diſtinguiſhed from all others by the two well marked characters of bringing forth their young living, and of being provided with *mammæ*, they have been called *mammalia*: theſe are,

under other anatomical relations, viviparous quadrupeds and cetacea. The very beautiful form, the diſtinct protuberance, the hemiſpherical and prominent ſurface, the delicate ſkin which the breaſts of women exhibit, and which conſtitute one of the charms of beauty, the amenity and contour of which artiſts repreſent with ſuch graces, are attributes peculiar to the human ſpecies. We do not find them in the females of any other animals: the number of two is alſo given to but very few ſpecies of theſe. In moſt, the number of mammæ amounts to between four and ten. The female elephant, the mare, the gazelle, and in general thoſe animals that have only one or two young have alſo only one or two mammæ, but ſhaped very differently from thoſe of woman. The nipple is ſingle in each mammæ in woman; it is quadruple in the cow.

3. In works of phyſiology and medicine, examples are frequently quoted of milk ready formed, ſwelling the mammæ of ſome male children and animals, and even of ſome adults: the preſence of this liquid in young girls before the age of puberty is ſtill more frequently ſpoken of. Hence it is concluded that there is no neceſſary dependance between this formation of milk and the act of generation; but theſe rare facts, contrary to the accuſtomed order of nature, do not prove the opinion which is attempted to be eſtabliſhed upon this point; for no accurate experiment has proved that this was real

milk: and as for its having a ſweet or inſipid taſte, an humour formed in ſome circumſtances and by ſome cauſes independent of pregnancy, is not real milk. This rare phenomenon has never been deſcribed except in man, and it has not been obſerved in the animals whoſe paſſions and manner of living are not, like ours, contrary to nature, nor force her to deviate from her ordinary courſe.

4. Under the ſkin of the mammæ are maſſes of ſolid and granulated fat, which it covers; and in a cellular texture with large meſhes is incloſed a conglomerate glandular apparatus, covered with a hard and white integument that occupies the middle of this prominent organ. This apparatus is formed of parcels ſeparated by membranous cells, and theſe parcels are themſelves formed of hard, ſolid, entire grains without cavities, compoſed of implicated veſſels. This mammary gland exiſts in males and in infants, but much ſmaller, and not ſurrounded with fat as in females: fifteen or twenty excretory ducts, viſible, elongated, hard, of a diameter ſufficiently conſiderable during the period of lactation, are collected below the areola of the breaſt, and proceed, without confounding themſelves or an aſtomoſing with each other into the nipples, where they open externally; they are inflected into the rugoſities of the papilla or nipple, and elongated or diſtended when the nipple itſelf is elongated by the

kind of erection which friction or ſuction produces in it. A multitude of other thin and long ducts are obſerved, which open into the adipoſe texture, which do not belong to the glands, properly ſo called, and which Haller imagined to pour a fatty humour into the milk.

5. When the uterus has conceived, the mammæ gradually grow larger, their glandular texture tumefies, the orgaſm pervades it, the diſpoſition to form milk gradually eſtabliſhes itſelf, which is announced by a limpid or turbid ſeroſity diſcharged by the papilla. After the birth of the infant, the womb having contracted itſelf again three or four days after delivery, the milk begins to be really formed; the mammæ become diſtended, ſwelled, and painful, and the milk diſcharges itſelf ſpontaneouſly. The ſuction of the infant greatly accelerates its diſcharge, and augments its production. There firſt runs out a very liquid ſlightly and opaque liquid, which is the coloſtrum; ſoon afterwards, this liquid becomes daily thicker, more perfect, white, odorous, ſavoury, and ſuſceptible of affording a more and more ſubſtantial nouriſhment to the ſuckling. It continues to flow for whole years, when the ſuction and the irritation are not interrupted, and the quantity which is formed is ſometimes ſo abundant that a nurſe can ſuckle ſeveral infants at the ſame time.

6. The formation and, as it is called, the riſing of the milk has great relation with the functions of the uterus. It ſeems at firſt that a really milky liquid is formed in this viſcus; and the lochia, which have in part the ſame character, flow till the period when the milk is abundantly ſecreted in the breaſts. Phyſicians believe that this liquid actually paſſes from the uterus into the breaſts, and a great number of facts proves this ſympathy between theſe two organs. They both aſſume their peculiar activity at the ſame period: the breaſts become prominent as ſoon as the menſtrual diſcharge appears, or the genital parts develop themſelves; the milk begins to be ſeparated when the menſtrual diſcharge diſappears in conſequence of pregnancy; its ſuppreſſion cauſes the mammary glands to become humid: theſe glands collapſe when the menſtrual diſcharge ceaſes; and theſe two organs, the womb and the breaſt, become inactive, and are excited into activity at the ſame periods. Phyſicians even avail themſelves of this action when, in order to diminiſh the too great abundance of the menſtrual evacuation, they apply a cupping glaſs to the breaſt. Diſcharges by one or the other way ſucceed, and correſpond with each other. This relation is alſo proved by the ſenſation which the titillation of the nipples excites in the genital parts; accordingly the ancients admitted the concurrence of the uterus in the formation of milk.

7. Some anatomiſts admit the blood only as the ſource of the milk; they believe the mammary arteries to be its ſole origin. The ſmalneſs of theſe ſanguineous ducts has induced others to think that the arteries do not furniſh the only matter of the milk. Haller admitted in it the admixture or the addition of fat by the ducts of which I have ſpoken. It is pretty generally believed that the chyle contributes more abundantly than the blood to the formation of the milk, becauſe its quantity is always proportionate to that of the nouriſhment; becauſe the chyliferous veſſels exhibit to the anatomiſt a liquid analogous to milk; becauſe milk has frequently the ſmell and ſeveral of the characters of the aliments; and laſtly, becauſe nurſes feel the milk flow into their breaſts at the moment when the chyle aſcends into its veſſels. For theſe reaſons phyſicians have believed that theſe two liquids are ſimilar to each other, and have deſcribed the properties and the morbid affections of the different elements of the chyle like thoſe of the milk: but this analogy, when carried too far, may be erroneous, and experience has not yet proved it in a direct manner. I am much more inclined to believe that the intire lymph, the quantity of which is augmented, and its motion accelerated by the chyle at the moment when it aſcends from the inteſtines into its ducts, contributes to the production of the milk, and that while the blood furniſhes the albumino-caſeous part, the fat affords

fords the butyraceous, and the lymph the ſerous.

8. When the milk is well formed, and diſtends its reſervoirs, frequently the lactiferous or galactophorous tubes, being opened and dilated, diſcharge it ſpontaneouſly: a kind of orgaſm pervades theſe tubes, erects them, dilates them, afterwards contracts them, and gives them that motion, that action which frequently cauſes the milk to iſſue out in more or leſs rapid jets. That ſuction, or the art or mode of which nature has given to the infant from the neceſſity of nouriſhing himſelf with it, ſingularly favours its diſcharge. The vacuum formed round the nipple, with the aid of a ſucking inſtrument, or by means of the neck of a heated bottle applied to it, and the preſſure of the air which applies itſelf with advantage to the hemiſphere of the mammæ, ſolicits this diſcharge with ſuch energy, that we ſee it ſpout out in white streams, of which frequently ſix or eight are very evidently perceived in the females of animals; the action of preſſing the udder from above downwards as far as the extremity of the teat, in milking, or the art of milking, cauſes the milk to flow with facility and celerity. The animals that have had their young taken from them readily ſubmit to this extraction, which is attended with a pleaſurable ſenſation to them. Nature has connected with this excretion a pleaſurable ſenſation which doubles that of being a mother,

ther, and which attaches, by the gentle bond of gratitude and tenderneſs, the infant who acknowledges no other mother than her by whom he is nouriſhed.

9. The influence which the aliments have upon the formation of the milk, likewiſe merits all the attention of the phyſician. It is known that well-fed animals afford milk of good quality in abundance. Nurſes diſtinguiſh foods by the property which they poſſeſs of increaſing or diminiſhing the proportion of this liquid. The acrid ſmell of garlic, of the alliaceous and of the cruciferous vegetables, paſſes into the milk; the perfume of flowers, the aromatic odour of ſaffron and of thyme, the ſugar of the roots and fruits, the nectar of the petals, give it an agreeable aromatic ſmell and a pleaſant taſte. The red juice of the opuntia, the reddiſh juice of madder, the blue of indigo, vary the colour of this nutritive liquid with the animals into whoſe food theſe colouring matters have been introduced; the bitterneſs of wormwood, the acrimony of the milk-thiſtle, the aſtriction of the aſtringent plants, the purgative property of the Gratiola, are recognized in the milk; different medicinal properties are given to it, according to the different kinds of nouriſhment which are preſented to animals. The milk of a nurſe who has taken a purgative, produces gripes and evacutions in her ſuckling. Wine, beer, the different vinous liquors, give it a diſtinguiſhable

property; even poiſons, and ſeveral diſeaſes, are tranſmitted in this way; and the milk participates of whatever has been introduced into the ſtomach of the woman who affords it.

10. Even the paſſions with which a nurſe is agitated, modify both the abundance and the properties of the milk that is ſecreted in her breaſts; anger has been known to derange the ſyſtem of the infant, and to give it convulſive motions. Chagrin, ill humour, bad news, fear, depreſſion of the ſpirits, vitiate the ſources of the milk, and ſometimes produce a ſudden collapſion of the breaſts. Bad treatment to nurſes, manifeſtly alters their milk: accordingly great care is taken of the female animals deſtined to furniſh milk for the table, not only in the cleanlineſs and nature of their food, but alſo by kindneſs, careſſes and attentions of every kind. Several phyſicians have even carried this influence of the paſſions upon the milk ſo far, that they have pretended the milk itſelf influenced the character and the paſſions of the young individuals that are nouriſhed by it: thus it has been pretended that infants who have been ſuckled by choleric and paſſionate, mild and benevolent, lively and ſalacious, or ſtupid and phlegmatic women, acquire the ſame moral diſpoſitions. But there is reaſon to believe that this opinion is carried too far, that it is rather from the example of the effects of theſe different paſſions that the infants gradually model themſelves, and that they are only

imitators of their motions inſtead of being phyſically changed in their ſenſorium.

SECTION II.

Of the Phyſical Properties of Milk.

11. THE quantity of the milk is varied in woman and in the animals by a multitude of circumſtances. Abundance of drink in general, induces an abundance of the mammary liquid; ſoft, highly nouriſhing and eaſily digeſtible aliments produce the ſame effect. The farinaceous aliments boiled in water, when the ſtomach digeſts them well, increaſe its quantity, and nurſes are well acquainted with this kind of influence. It is difficult to fix the limits, or indicate the average terms of this production: it appears however in general that the milk moſt frequently conſtitutes a third or a very little more of the weight of the aliments. There have been nurſes however, who, beſides the milk which they afforded in abundance to their infants, yielded ſtill ſpontaneouſly from one to nearly two kilogrammes of this liquid in the day; in the female animals with which this quantity is much more conſiderable, it is ſufficiently known to vary according to the ſeaſons, the places which they inhabit, the paſturages in which they are placed, the nature

of the fodder which is given them in their ſtalls, their age, and the time more or leſs remote from the period when they have brought forth young.

12. The ſpecific gravity of milk is in general more conſiderable than that of water; Haller ſays that it is to the latter as 277 to 261, or 1043, 1000. It varies, according to him, and the different authors whoſe obſervations he has collected in the following proportions, 1026, 1029, 1035, 1000.

Citizen Briſſon, in his treatiſe upon the ſpecific gravity of bodies, gives the following table of that of the different milks, water being ſuppoſed 10,000.

Womans' milk - -	10,203
Cows' milk - -	10,324
Goats' milk - -	10,341
Mares' milk - -	10,346
Aſſes' milk - -	10,355
Ewes' milk - -	10,409

13. Milk is in general of an opaque white colour, which however inclines towards yellow in woman, towards blue in the cow, and varies in the ſame female according to the proportion of its principles, and conſequently, according to a multitude of circumſtances. However its opacity and its whiteneſs are conſtant, on which account it has been compared to an emulſion, and the latter has been called *milk of almonds.*

Its conſiſtence is that of an oily and aqueous liquid at the ſame time; when it is very ſtrong and very good, it is a little thick, a drop remains upon the nail without running down, and extends itſelf upon it ſlowly: it is in this manner that phyſicians judge of the milk of nurſes; a certain degree of fluidity is nevertheleſs preferable to a too ſtrong conſiſtence.

14. The taſte of milk is bland, agreeable and in general almoſt ſaccharine; it has however many modifications in the different ſpecies of animals; it has ſomething unctuous and fatty which diſtinguiſhes it, which manifeſtly depends upon its oily nature. Milk has a particular ſmell, which is pretty generally agreeable; this is one of the properties in which it is moſt ſuſceptible of variation, according to the nouriſhment. That which is peculiar to it is however inherent in its intimate nature, and independent of the perfume or the bad ſmell proceeding from the aliments; it ſubſiſts only as long as it is warm; it is moſt perceptible at the moment when it has been diſcharged from the mammæ; it is ſcarcely to be perceived at all when it has entirely cooled; it is renewed by expoſure to heat; it is diſſipated by ebulition. It is very perceptible and recognizable in clean dairies, at the moment when the warm new milk is depoſited in them. The milks of different animals have a particular and well-marked character in their odour.

15. According to the obſervations of Citizens Deyeux and Parmentier, the milk furniſhed by a cow at different periods, in the ſpace of twenty-four hours, preſents great differences, eſpecially if the milkings are multiplied at irregular diſtances of time. The changes of the atmoſphere, for the animals fed by paſture, are the principal cauſes of theſe differences. The moſt ſingular remark which they have made relates to the diverſity of the milk of a ſingle milking, according to the manner in which this milking is divided, and the udder evacuated at different times. The product of one milking performed with care and received ſucceſſively into four veſſels, affords really four ſpecies of milk: the firſt is the moſt ſerous: the ſecond product is leſs ſo; the third ſtill leſs, and the fourth contains a very large quantity of cream. The dairy women have long been acquainted with this phenomenon, and they avail themſelves of it, by keeping apart the laſt product of the milking, in order to ſell it, under the name of cream, to thoſe who prefer the ſweet, unctuous, thick and fat milk which goes by this name.

16. The times at which the milk is examined preſent variations according to the different lengths of time that have elapſed ſince parturition and the firſt formation of the milk. The moſt ſtriking of theſe differences obſerved in the milk is that which characterizes it in what is called the *coloſtrum*, which is firſt formed immediately after parturition. The coloſtrum

is a fluid of a deep yellow colour, thick, viſcid and ropy, frequently carrying with it ſtreaks of blood, affording much yellow cream; and this a fourth more than the real cream of a deep yellow very ſolid butter, with a liquid leſs white and opaque than the ordinary milk, not coagulable, like the latter, by means of rennet, but viſcid and ropy, little ſaccharine. The coloſtrum changes much; from the ſecond day it loſes ſomewhat of its yellow colour and of the abundance of its cream. In four days, it paſſes into the ſtate of ordinary milk, and it is not till this period that the milk-women begin to vend it in our towns. Reckoning from this fifth day, the milk of the cow becomes conſtantly more and more perfect, acquires a better conſiſtence till the third month when it is the moſt perfect.

SECTION III.

Chemical Examination of the entire Milk.

17. I HAVE already obſerved that the milk has been the object of much labour and reſearch. Boyle has made it one of the ſubjects of his experiments. Boerhaave firſt treated in a ſufficiently detailed manner. Hoffman alſo made it the ſubject of many experiments. Macquer has deſcribed with much clearneſs and preciſion the proceſſes of its analyſis, and he was ac-

quainted with its principal properties. Spelman occupied himſelf with its fermentiſcible property ; Rouelle the younger with the mucoſo-ſaccharine matter and the ſalts which it contains. Scheele diſcovered the ſachlactric acid, and ſhowed that the milk afforded in ſome caſes acetous acid, and that the ſpecies of acid into which it is ſpontaneouſly converted has particular and characteriſtic properties. I have given, in 1790, ſeveral new obſervations on the different materials of milk. Finally, Citizen Deyeux and Parmentier have made a great number of reſearches upon the milk of the cow, taken under many different circumſtances, upon the economical properties of this animal liquor and of its products, and upon the changes or modifications of which it is ſuſceptible. Their very extenſive enquiry concerning all theſe objects conſtitutes at preſent an entire work, which preſents the moſt complete hiſtory of this animal liquor. I have here mentioned only ſome outlines of this chemical notice and ſome of the principal authors of its analyſis. We might alſo add the numerous facts deſcribed by Verheyen, Barchuſen, Verduc, Doorſchodt, Egeling, Young, Gouraigne, Acoramboin, Geymuller, Cartheuſer and Gmelin, who have either in phyſiological works or in monographic treatiſes, given more or leſs valuable details concerning the milk of different animals. Haller has laboriouſly collected from theſe numerous writers the facts which he has employed for his hiſtory of milk; and as the mode of proceeding of theſe authors was not uniform, thoſe multiplied quotations are more capable of embarraſſing than enlightening the reader.

18. Milk expoſed to a moderate fire dilates and ſwells conſiderably: this property is known in the domeſtic uſes of milk; it has been obſerved that it boils at the 199th. degree of Fahrenheit, that alcohol boils at 181, and water only at 212 of the ſame thermometer. There is formed at its ſurface a pellicle which gradually thickens, wrinkles, dries and grows yellow in drying. This is caſeous matter which ſeparates and becomes ſolid; when it is removed, and when we continue to evaporate the milk, there is formed a ſecond pellicle, and ſo on ſucceſſively. It is obſerved that theſe pellicles are thinner and more tranſparent in proportion as the evaporation advances; they ſeparate in this manner till there remains only a ſerous and almoſt tranſparent liquid in the veſſel. In order to obtain and perfectly ſeparate the laſt portions of the caſeous matter in this ſtate of pellicles, we muſt take care to add, towards the end, water diſtilled from the milk; when this liquid affords no more pellicles, it is no longer ſuſceptible of coagulation.

When we evaporate the entire milk to a thick conſiſtence, we obſerve that it undergoes a real coagulation, and that maſſes are formed in it; its ſolid matter, when once thickened, aſſumes a yellowiſh colour however little we may heat it more; before it acquires this colour, and when it is ſtill ſoft, though thicker and more ſolid than honey, it conſtitutes *franchipane*, a kind of ſweetmeat which is prepared by adding to the milk pounded almonds, ſugar, and orange-flowers, towards the end of its evaporation. Formerly the extract of milk was kept for preparing the whey of Hoffman by adding hot water to it. This is almoſt always a bad medicine, becauſe the extract very eaſily ſpoils, and becomes acrid and rancid.

19. When milk is heated in cloſe veſſels, and when it is evaporated on the water-bath, a large quantity of water, very little odorous and inſipid, is obtained, which preſents no phenomena by the re-agents, but which however carries along with it ſome matters in vapour, ſince it putrefies, depoſits light flakes, and becomes fetid when it is kept. This diſtilled water was formerly prepared in the laboratories of pharmacy, and great virtues were attributed to it which have at laſt been diſcovered not to exiſt. The milk is thickened and coagulated after having furniſhed this aqueous product which conſtitutes nearly two thirds of its weight, when the operation is carried ſo far as to obtain the reſiduum in the form of extract. When the extract itſelf is diſtilled by the retort it affords a turbid, reddiſh, fetid water, charged with zoonic acid and ammonia, a pretty abundant quantity of fluid oil of a

brown colour, a portion of concrete and empyreumatic oil, of ſolid and cryſtalline carbonate of ammonia, of carbonated hidrogen gas and carbonic acid gas. The coal which remains after this operation is conſiderably voluminous; by incineration it leaves in its aſhes ſome traces of muriate of ſoda, of muriate of pot-aſh much more abundant than the firſt and of phoſphate of lime. Rouelle, who found in milk the preſence of pot-aſh in the ſtate of muriate, has remarked that this kind of alkali does not exiſt in the blood, but contains only ſoda, either pure or combined with muriatic acid. This may ſerve to prove that another matter beſides the blood contributes to the ſecretion of the milk; and if it affords reaſon to believe that it is the chyle as proceeding immediately from vegetable aliments—for it is the milk of the cow of which we ſpeak, it announces at the ſame time that the ſalts of pot-aſh change in paſſing into the blood. Both theſe conſiderations preſent chemical problems the ſolution of which is of great importance.

20. Milk expoſed to the air quickly becomes covered with a layer of light matter, of a duller white than the entire milk, which itſelf at the ſame time becomes more limpid, and aſſumes a blueiſh tinge. This white layer, which is of a bland unctuous taſte, conſtitutes the cream; it ſeparates more or leſs quickly, according to a multitude of circumſtances, and in a quantity which, in the milk of the cow, always correſ-

ponds with the goodneſs and abundance of the nouriſhment; hence the poetical expreſſion of fat paſturage. It is more yellow and conſiſtent, the more this nouriſhment is abundant and of good quality. The cream contains the butyraceous oil, which is not yet butter ready formed, with a ſmall quantity of very light and very bland caſeous flakes, and a conſiderable proportion of whey or ſerum. Though the cream alone furniſhes the butter, it never ſeparates ſpontaneouſly and without agitation; it is known that it may be converted into light and fat cheeſes. Cream is one of the products of milk upon which the quantity and quality of the nouriſhment given by the aliments has the moſt influence. It is ſingularly changed, diminiſhed in quantity, and aſſumes a diſagreeable ſmell in diſeaſes, as is conſtantly obſerved in the epidemic diſeaſes of animals. I have obſerved that the contact of the air contributes much to the ſeparation and the butyrization of cream. It is obtained more ſpeedily in flat and wide veſſels, which preſent a large ſurface to the atmoſphere, than in narrow veſſels. I ſhall revert to this phenomenon in the hiſtory of butter.

21. The entire milk, the intoxicating property of which ſome travellers have announced, eſpecially the mare's milk in Siberia, and that of the ewe in the Hebrides, is ſuſceptible of paſſing into the vinous fermentation. This art has long been practiſed by the

Tartars and the Nomadic nations. They leave the mare's milk in large buckets, and even mix it with blood, and they obtain from this mixture an intoxicating liquor which they uſe inſtead of wine. It has been found, in performing this experiment with care, that the vinous fermentation of the milk does not take place unleſs when it is in conſiderable maſſes; that the integrity of all its elements was requiſite to the effect; that it did not eſtabliſh itſelf well except in milk of good quality and above ten degrees of temperature; that a ſlight and repeated agitation of this liquid in cloſe veſſels accelerated and favoured it, by mixing well all its materials which tended to ſeparate from each other; that there was diſengaged a conſiderable abundance of elaſtic vapour, to which it was neceſſary to give vent from time to time, and that this was carbonic acid; that there was formed a viſcid and tenacious ſcum, a ſort of coating at its ſurface; finally, that the milk, whilſt it underwent this inteſtine and vinous motion became in part acidified and coagulated. When theſe phenomena have taken place, the milk, which is clotted, of a pungent ſmell, acidulous and vinous at the ſame time, being ſubjected to diſtillation, by a ſlight ebullition, affords a product of alcohol in little abundance, and acid at laſt, which may be rectified by two ſucceſſive diſtillations, and preſents all the properties of this liquid, which is identical in all caſes, as it always proceeds from one common ſource: but its quantity is always ſo ſmall that it can never be extracted from milk with advantage. It will appear that the ſlightly ſaccharine matter contained in this liquor is the true origin of this alcohol, and the cauſe of the vinous fermentation of which it is ſuſceptible.

22. If the temperature of the air exceed fifteen degrees; if the milk be expoſed to the air; if it be agitated in order to retard the ſeparation of the cream and to keep the materials well mixed together, it paſſes into another kind of fermentation, and acquires an acidity ſenſible both to the ſmell and the taſte. Every one knows that milk turns ſpontaneouſly ſour when it is kept for ſome time; that great changes of the atmoſphere, eſpecially electric commotions and tempeſts contribute greatly to this aceſcence: that it is retarded by boiling it, which is attributed to the diſengagement of its odorous matter, though it has perhaps no influence upon this property: at the ſame time that it undergoes this change the milk curdles or coagulates; its conſtituent materials ſeparate; ſolid clots more or leſs voluminous are precipitated from it; frequently even this ſeparation of ſolid matter takes place in a ſingle piece, and we ſee a white opaque, ſemi-concrete maſs, ſhrunk together, and ſurrounded with a yellowiſh liquid a little turbid, which gradually augments, and ſeparates from the ſolid maſs in proportion as the particles of the latter approach and condenſe.

The portion of the milk thus ſpontaneouſly thickened and coagulated is called the curd, and the liquid is denominated the whey. The latter has a ſour taſte and a pungent odour; it is in proportion and at the moment when it has acquired this taſte that the caſeous matter becomes ſolid and ſeparate. In this manner a new acid is formed, which ſhall ſoon be examined by the name of *lactic acid.* In the ſpontaneous decompoſition of the milk, and in its ſeparation into ſolid and liquid matter, we find a remarkable analogy with what happens to the blood; but here it is the product of an acidification which does not take place in the vital liquid, and the compariſon if carried too far becomes a real error.

23. Though it be well proved that milk is ſuſceptible of forming by fermentation an acid of a particular nature, it is however not leſs capable of aſſuming by a ſlight modification the character of true acetous acid. Scheele has found that by mixing ſix ſpoonfuls of alcohol with about three litres of milk; ſuffering this mixture to ferment in a well-corked bottle, and taking care to give vent from time to time to the elaſtic fluid diſengaged during this fermentation, the milk was converted at the end of a month into very good vinegar. It is only requiſite to paſs it through a piece of linen in order to ſeparate the coagulated caſeous part, and then to keep it in well cloſed veſſels: it may be employed, like real vinegar for economical and domeſtic uſes.

We ſee in this property the conſequence of the vinous fermentation and the rapid paſſage of milk into the ſtate which commonly follows wine, when we begin by adding to it a portion of the eſſential product of this fermentation: thus is eſtabliſhed a very remarkable analogy of nature between the lactic acid and the acetous acid.

24. Milk is coagulated and decompoſed by all the acids, the ſtrongeſt as well as the weakeſt. Of all the animal liquors it is that which preſents the moſt prompt and eaſy coagulation. A large quantity of curds more or leſs voluminous is formed and ſeparated from it at the very moment when an acid is poured into it; when it is concentrated and agitated a little, it produces a ſolid curd which however divides into flakes by further agitation. Every one knows the uſe of the weak acids in effecting the coagulation of milk. The curd thus formed and well drained retains no acid taſte, and the acid that has been employed remains entire in the ſupernatant liquor. It is therefore by uniting with the ſerum that the acids ſeparate the caſeous portion, and it is to its tendency to become concrete that the coagulation of this matter is to be aſcribed. This we ſee eſpecially in the curd ſpontaneouſly formed, which retains none of the acidity of lactic acid when it has been drained, preſſed and waſhed. We ſhall hereafter ſee that this effect is produced by the attraction of the acid in general for the water of the milk, by the little ſolubility of the

inſulated caſeous matter, and by the little attraction of the acid for this matter.

25. The alkalies do not produce the ſame effect of coagulation upon milk, though they firſt ſeparate the cheeſe from the water, and thicken this fluid at firſt, becauſe they have a very ſtrong attraction for the caſeous ſubſtance. Their action upon milk has even been oppoſed to that of the acids, becauſe when an alkali is added to this liquid once coagulated, the coagulum is actually re-diſſolved, by ſtrong agitation. Ammonia eſpecially enjoys this property; it diſſolves the curds formed in milk by the acids very quickly and eaſily: it re-eſtabliſhes in ſome meaſure milk that has been turned in ſome hot drinks; and it is employed for fuſing the milk and cauſing it to flow in the breaſts of lying in women, when they are attacked with that very painful diſeaſe the trichiaſis. Boerhaave having obſerved that the *oil of tartar*, or a condenſed ſolution of pot-aſh proceeding from burnt tartar, being boiled with milk, gave it a yellow colour which paſſed into the red, thought that this phenomenon reſembled the blood, and that this liquid proceeded from a ſimilar combination between the chyle and the alkaline humours. This effect of colouration, which never goes ſo far as redneſs, and is very different from the phenomenon of ſanguification, depends upon the re-action of the alkali upon the caſeous matter of the milk and upon the tranſition

of this matter into the ſtate of a kind of carbonated oil, as I ſhall ſhow hereafter.

26. The ſalts, of whatever nature they may be, have conſiderable action upon the component materials of milk, in ſeparating them from each other, and it is in this manner that they decompoſe and coagulate this liquor. It can only be by their attraction for the water that they produce this effect; and we ſee that the greater this attraction is, the more ſpeedily they effect the coagulation of the milky liquid. Scheele well underſtood the cauſe and the preſence of this phenomenon.

The metallic ſalts and ſolutions act in a complicated manner upon milk, on account of the multiplied attractions exerted by the ſaline matters diſſolved in this liquid; but we muſt here confine ourſelves to the enunciation of their coagulating and decompoſing action in general, conſiſting in the ſeparation of the caſeous matter. Other details of their effects belong to the particular properties of the inſulated materials of milk, and we ſhall treat of them in the ſubſequent paragraphs.

27. It is known by all the economical uſes of milk, that this liquor unites eaſily with ſeveral vegetable matters; that combines with gum, ſugar, the amylaceous fecula, the aromatics and ſeveral colouring matters; that ſome give it a more or leſs thick conſiſtence, and agreeable taſte, a pleaſant perfume, and varied colours. But chemiſtry ſhows that theſe combinations

are merely tranſient, that they take place only at the expenſe of the nature itſelf, and of the intimate mixture which conſtitute this liquid, ſo that it is more diſpoſed to be altered and decompoſed. Scheele has proved that all theſe matters, diſſolved in the milk and eſpecially if heated with it, effect its coagulation and the ſeparation of the cheeſe. He has conſtantly attributed this effect to the ſolution of theſe matters in the water, and to the ſuperiority of their attraction for this liquid over that which the caſeous ſubſtances has. Many flowers, grains, leaves and parts of vegetables in general exert the ſame decompoſing and coagulating action upon milk, though the plant which has received the French appellation of Caille-lait (*gallium*) poſſeſſes this properly in an inferior degree ſo many others, as Citizens Deyeux and Parmentier have found. Many of theſe vegetable ſubſtances are employed, as we ſhall ſee, for inſulating the caſeous from the ſerous part. We find the ſame effect in ſeveral animal ſubſtances, both mucous and gelatinous, ſuch as the membranes of the ſtomach of man, of birds, &c. fiſh-glue, the ſkins of all animals, whether acidulous or ſuſceptible of aceſcency, as runnet, and animal jelly, and they are employed for the ſame uſes. Alcohol alſo decompoſes milk, and coagulates it into very ſmall flakes, which may be immediately rediſſolved in water. This ſeparation of the flakes of cheeſe and butter proceeds, like that of a diſſolved ſalt from the attraction which alcohol has for water.

28. All theſe chemical phenomena of the entire milk prove that this liquid is a very compound ſubſtance, the materials of which are but feebly united with each other. It preſents itſelf as a momentary combination, a kind of ſuſpenſion of fat and oily matter in a mucous and ſaline liquid, the adheſion of which is but weak, the equilibrium little permanent, and the principles of which tend to ſeparate by a multitude of cauſes. On this account milk has been conſidered as a kind of animal emulſion, and compared to that which is obtained by the trituration of oily and mucilaginous ſeeds in water, to the thick liquid which is prepared by triturating gum and oil with this fluid; but in order to know whether this compariſon affords an exact notion of the nature and compoſition of milk, the properties of each of its component materials muſt be examined; namely, the ſerum, the caſeous part and the butter.

SECTION IV.

Of the Serum of Milk, or of Whey.

29. THE ſerum of milk, or whey, is the moſt abundant part of this liquid. We do not here treat of what is called *whey* in the dairies, or of the liquor ſeparated by aceſcence; it is of the ſerum not turned ſour that I intend to ſpeak, and particular proceſſes are requiſite for extracting it or ſeparating it from the milk: the following is that which is generally employed with ſucceſs. The entire milk is heated, runnet being added to it in the proportion of about a gramme to the litre: this ſubſtance, proceeding from the reſidue of the milk coagulated in the ſtomach of the calf and the gaſtric juice which is mixed with it, cauſes the milk to coagulate with facility. It is then ſuffered to boil for ſome moments, after which it is paſſed through a ſtraining cloth: there runs off a liquid ſtill turbid, which is to be clarified with white of egg andagitated in a little water; when it has cooled it is filtrated through a double paper without ſize. We may employ the membrane of the ſtomach of birds, or the flower of the thiſtle, or of the artichoke for coagulating milk. When we employ the tartarous acidule in fine powder, or vinegar, the whey which we obtain

is not pure, but preſents properties that do not belong to that fluid.

30. The whey or the ſerum of milk thus prepared is a liquid perfectly limpid, of a greeniſh-yellow colour, of a light faint and ſweetiſh ſmell when hot, inodorous when cold, of a ſweetiſh, ſlightly ſaccharine and unctuous taſte. Its ſpecific gravity is a little leſs than that of the entire milk; Muſchenbroeck had eſtimated it at 1016, the milk from which it proceeded being 1030; Citizen Briſſon gives for the ſpecific gravity of the milk of the cow 10,324, and for that of the clarified whey which was extracted from it, 10,193. Previous to its clarification it ſtill contains a ſmall quantity of caſeous matter, which impairs its tranſparency and is ſuſpended in it in flakes. By a mild heat continued for ſome time, it clears and depoſits theſe flakes. It is alſo, in this ſtate, turbid, and of a greater denſity than after its clarification. The denſity of this purified liquor proves that it is very different from water, which is alſo confirmed by its colour and taſte: accordingly, whey is a very nouriſhing liquor. Beſides thoſe patients who are ſupported and ſometimes even too highly nouriſhed with this animal liquor, the hiſtory of the arts preſents two remarkable facts reſpecting this property, which relate to two celebrated men. Boerhaave lived ſeveral ſucceſſive months without any other nouriſhment than whey, and Ferguſon made it his nouriſhment during eighteen whole years,

adding to it only a ſimple decoction of barley.

31. The action of heat upon whey affords reſults different from thoſe which milk preſents. When evaporated in open veſſels, or diſtilled on the water-bath, there is ſeparated from it a large quantity of ſlightly odorous water, which contains nothing ſenſible to the re-agents, though it becomes altered by putrefaction; the whey becomes coloured, grows brown, turbid, thick, becomes viſcous and concrete like granulated honey: if in this ſtate it be heated in a retort, it does not furniſh the ſame products as the entire milk; they have not the ſame fetidity; they do not contain an equal proportion of carbonate and of zoonate of ammonia; we find in them on the contrary pyromucous acid and ammoniacal pyromucite; the gas is leſs carbonated hidrogen than carbonic acid; the coal which it leaves is light and burns eaſily; we find in its aſhes a ſmall quantity of carbonate of pot-aſh, of muriate of ſoda, and more of the muriate of pot-aſh and phoſphate of lime.

32. When we evaporate the ſerum of milk to the conſiſtence of a ſyrup, and afterwards let it cool ſlowly, there are depoſited from it irregular cryſtals of a brown yellow colour, of a fat and unctuous appearance, which, when re-diſſolved in water and purified by two ſucceſſive operations, paſs through the yellow tinge and at laſt arrive at the ſtate of white cryſtals in regular paralelopipeds. This matter

is what is called the ſalt or the ſugar of milk; a ſubſtance very remarkable in its properties, and which deſerves to be ſtudied with attention.

Kaempfer aſſures us that the Brachmans have long known the art of extracting the ſugar of milk. Fabr. Barthollet or Bartholdi, an Italian phyſician, was the firſt who made expreſs mention of it, in 1619. Etmuller, Guterman, Teſti, Werloſchnigg, Wallerius, Fickius, Cartheuſer, Vulgamoz, and Lichtenſtein have ſucceſſively written its hiſtory and examined its properties. Rouelle the younger, Scheele, Hermſtadt, Citizens Deyeux and Parmentier have eſpecially occupied themſelves with its nature and chemical compoſition. We ſhall ſee that notwithſtanding the labours of theſe able men, there ſtill remains ſomething to be deſired reſpecting this ſingular ſubſtance, the formation and the exiſtence of which in the milk preſent conſiderations of great importance to the phyſiologiſt.

33. The ſugar of milk is prepared in conſiderable abundance in the mountains of Switzerland, a country ſo renowned for the excellence of its paſturages, and for that of the milk of its cows, as well as its different products. They take the ſerum obtained from ſkimmed milk coagulated by runnet, boil it and evaporated it freſh, before it turns ſour, till it has acquired the conſiſtence of a thick ſyrup, and becomes fixed into a granulated matter by cooling. It is then poured into earthen moulds like the boiled juice of the ſugar-cane; in which

it condenſes into a maſs which is dried in the ſun: ſometimes it is poured into veſſels with flat ſides, in which it aſſumes the form of cakes. It is very impure in this firſt operation; it is refined by diſſolving it in water and clarifying the ſolution with white of egg; it is boiled again to the conſiſtence of a thick ſyrup, which is ſuffered to cryſtallize gradually by cooling: and thus afford white cryſtals in rhomboidal paralelopipeds. The mother-water which is decanted from the cryſtals depoſits others of a yellow or brown colour which are ſucceſſively purified or refined. It is not without great difficulty that ſome rudiments of cryſtals of ſugar of milk are obtained in the ſmall way in our laboratories; but we ſeparate this body in the granulated and honey-like form. It appears, when we take the average term of the proportions which authors have indicated in the different kinds of milk, that the maximum of its quantity is one-twenty-eighth and the minimum one-ſixtieth of the milk.

34. M. Lichtenſtein has made the analytical examination of the different varieties, or rather of the different ſtates of the ſugar of milk, which are ſold at different prices in the Helvetic Republic. The following are the principal of them which he diſtinguiſhes:

A. *The white and pure sugar of milk*, extracted from the purified ſerum.

B. *The aceſcent ſugar of milk* extracted from whey that has turned ſour: it is coloured, fatty, moiſt, and impure.

C. *The ſugar of milk mixed with mother-water or fatty parts*, as the author calls them, is that which ſeparates in the firſt cryſtallization.

D. *The ſugar of milk mixed with oil and muriate of ſoda*, which cryſtallizes the laſt.

E. *The ſugar of milk mixed with fat parts, with muriate of ſoda, and with muriate of ammonia;* this is adheſive and moiſt; it affords ammonia by the fixed alkalis.

F. Finally, a variety of ſugar of milk mixed with all the ſubſtances already indicated, and alſo with an extractive part and caſeous matter. This laſt, the moſt impure of all, becomes rancid: and in this ſtate it is acrid and pernicious. In France, the different varieties of theſe ſugars of milk are not known.

35. The ſalt or ſugar of milk, when well purified and cryſtallized, preſents to the chemiſt properties which belong to no other ſubſtance. It is white, cryſtalline, of a faint taſte, and ſeemingly earthy, notwithſtanding the name which it bears, unalterable by the air: it is much leſs ſoluble than ſugar, ſince four parts of hot water are required for the ſolution of one part of it; more than twelve of cold water are requiſite. Placed upon ignited coals, it becomes brown, fuſes not ſo well nor ſo ſpeedily as ſugar, exhales white fumes, having a pungent odour of caramel, the fumes of which they reſemble, ſwells, inflames, and leaves a

black coal, leſs light, rather eaſy to be incinerated, leaving $\frac{1}{300}$ (30 grains in the pound) of the weight of the primitive ſalt, in which Rouelle has found a mixture of three-fourths of muriate of pot-aſh, and one-fourth of carbonate of pot-aſh. Diſtilled in a retort, it affords water charged with pyromucous acid, ſome drops only of red oil, much carbonic acid gas, mixed with carbonated hidrogen gas, and a light coal of the nature already indicated. According to its properties, Rouelle and Vulgamoz have conſidered it as real ſugar. Scheele has confirmed that opinion by converting this matter into oxalic acid by means of nitric acid.

36. But a particular diſcovery of Scheele, relative to this ſugar of milk, has however ſhown that this kind of mucous body preſents a very eſſential difference from ſugar properly ſo called. In treating it with the acid of nitre, he remarks that it required more to change it into oxalic acid; that it afforded only a little more than one-eighth of its weight of this acid; and that there was gradually ſeparated from it a white powder, little ſoluble, in which he found the characters of a particular acid which he calls *acid of ſugar of milk*, and which has ſince been deſignated in our nomenclature by the name of *ſachlactic*, and of which I have given the hiſtory, under that of *mucous acid*, in the article concerning gum or vegetable mucus, becauſe this ſubſtance has, like the ſugar of milk, the property of affording it by

the action of the nitric acid. It has been ſeen in this article that Mr. Hermſtadt, who has inſerted in Crell's Annals of Chemiſtry two Memoirs upon the ſugar of milk, believed that the mucous or ſachlactic acid was oxalate of lime diſguiſed by a fatty matter; but Scheele, who had alſo ſuſpected the ſame could not verify it, nor has it received more confirmation from our experiments. From the little taſte and ſolubility of the ſugar of milk and its property of forming mucous acid like gum, I conſider it as a ſort of intermediate ſubſtance between the mucous ſubſtance and ſugar; I believe it to be the product of the work of digeſtion; for it is formed in the carnivorous animals, in the milk of which it is even abundant, as well as in the frugivorous, and it is difficult to believe that it paſſes immediately from the ſtomach into the mammæ by the chyle. Perhaps it may be this mucoſo-ſaccharine compound which is found in the urine of perſons labouring under the *diabetes mellitus.* Citizens Deyeux and Parmentier believe that the ſugar of milk, which they aſſert to be more ſoluble in milk than in water, is a combination of ſugar and ſachlactic acid, and that it may be formed artificially by uniting theſe two matters. I have no knowledge nor can I ſay any thing concerning the experiments upon which they ground this aſſertion, which I muſt confeſs however appears to me to accord very ill with what we know of the properties of the two ſubſtances which they ſuppoſe to be combined.

37. When we have obtained all the ſugar of milk contained in the ſerum, the liquid which remains as mother-water is brown, viſcous, thick, and gluey; it affords by cooling, as Rouelle the younger remarks, an almoſt tranſparent jelly, and it concretes into a tremulous maſs, like an animal decoction. It is in this mother-water alſo, that ſeveral ſaline matters exiſt, which may be ſeparated from it, if after having diluted it with a ſmall quantity of water, it be evaporated very gently, and with the attentions with which experiments of this kind ought to be conducted. They are cubes of muriate of pot-aſh which depoſit themſelves thus in the cryſtalline form: the phoſphates of ſoda and of lime, which form part of the depoſit, and which other experiments enable us to diſcover in it, are too little abundant and too much diſguiſed by the former cryſtals, to be perceptible in it. The re-agents by which they are indicated preſent particular phenomena with the entire milk previous to its evaporation or concentration; theſe are the alkaline and metallic ſolutions. Lime-water, the ſolution of ſtrontian and of barites precipitate the ſerum of milk very ſenſibly; the precipitate is an inſoluble earthy phoſphate. Pot-aſh, ſoda, and ammonia form in it a light maſs, which is only precipitated phoſphate of lime. Amongſt the metallic ſalts, the nitrates of mercury and ſilver

are thoſe whoſe action upon the ſerum of milk has been the beſt examined. The firſt forms in it a precipitate of a greyiſh-white colour, which becomes roſe-coloured by drying in the air; the ſecond, in precipitating it, remains in a white powder. Both theſe precipitates afford traces of phoſphorus when they are diſtilled alone or with pulverized charcoal at a ſufficiently elevated temperature. They are compoſed of metallic muriate and phoſphate coloured and ſoiled by a gelatinous animal matter. The action of the acids upon whey, has nothing remarkable; the concentrated ſulphuric acid colours and reduces it to coal; the nitric changes it into oxalic and ſachlactic. The concentrated whey turns ſyrup of violets green: Rouelle the younger attributed this colour to the yellow of the liquor.

38. We ſee that by the preceding re-agents the ſerum of the milk is altered only as to its ſaline ſubſtances, that they alone produce the effects announced, and that the mucoſo-ſacharine and gelatinous ſubſtances, which however conſtitute its principal materials, (for the ſalts amount in it only to ſome thouſandths,) experience no change or alteration, at leaſt not perceptibly by their precipitation by means of theſe re-agents. Indeed it cannot be doubted that the cauſtic alkalies and the powerful metallic ſalts act upon theſe two organic ſubſtances, as is indicated by the change of the colour of the fluid, and the colouration of

the precipitates; but theſe ſlight modifications are but little appreciable. Thus the object of the chemiſt, in treating whey by the re-agents, is particularly to exhibit its ſaline properties. There are, however, alſo means, without other re-agents, of ſeparating and obtaining diſtinctly the mucous and gelatinous compounds, and of diſtinguiſhing them from each other, and from the ſaline materials that are mixed with them. When the ſerum of milk thickened and concentrated by fire has acquired the conſiſtence of a thin ſyrup; if we throw into it a ſufficient quantity of alcohol, a flakey and mucous depoſit is formed which contains the ſugar of milk, and the gelatin, equally inſoluble in this liquid, and ſeparated from the water by reaſon of the ſtrong attraction which it has for alcohol. The ſerum thus thickened may be precipitated, though little abundant, by tannin which ſeizes only the gelatinous ſubſtance which it contains, and we may afterwards find again in it the mucoſo-ſaccharine ſalt which it contains by the addition of alcohol, which precipitates it in its turn.

39. I have ſtrongly inſiſted in my experiments on the analyſis of the ſerum of milk upon the preſence of the phoſphate of lime, which, by its quantity, has appeared to me to follow immediately after the muriate of pot-aſh. We find it in the aſhes of whey when entirely evaporated and burned, or in thoſe

of the coal which it leaves after its diſtillation. It is this which is precipitated by the addition of pot-aſh, of ſoda, and of ammonia, in well clarified whey, and the precipitation of which becomes much more ſenſible which this humour has been previouſly concentrated by evaporation. The oxalic acid which conſtantly renders the ſerum turbid, and forms in it a precipitate of oxalate of lime, affords alſo the proof of its exiſtence by the earthy baſe which it takes from it: the phoſphates of mercury and lead which are obtained by the nitric ſolutions of theſe metals, and which contain its acid, complete the proof. The little ſolubility of this ſalt, and its exiſting nevertheleſs in the proportion of ſeveral thouſandths in milk, prove that it enters into the plan of nature to furniſh it conſtantly to the young animals in this firſt nouriſhment which they take ſo greedily and ſo abundantly. I have thought I had found the reaſon of this view of nature in the rapidity and energy of oſſification at this tender age of life.

40. One of the moſt characteriſtic properties of the ſerum of milk is that it turns ſour with great facility: perhaps it paſſes previouſly into the vinous fermentation; but this is ſo feeble and ſlight, that it is difficult to ſeize the inſtant of the tranſition. The aceſcence on the contrary is the moſt conſtant and the moſt marked phenomenon which this liquid preſents in the courſe of its ſpontaneous alterations. It is by

this motion that the lactic acid is formed. The whey commonly becomes turbid and depoſits ſome light flakes of caſeous matter in proportion as it becomes ſour: if we add two or three ſpoonfuls of alcohol to each litre of this ſerum, we obtain acetous acid inſtead of lactic acid, as with the entire milk. I have already remarked that Scheele in examining milk that had ſpontaneouſly become ſour, diſcovered a particular acid in it: he has given both the means of purifying it and the hiſtory of its principles and combinations. No chemiſt has added any thing to the work of Scheele. It is proved that the formation of this acid is owing to the alteration of the ſugar of milk or of its mucoſo-ſaccharine matter; for when this acid is once well formed, when the whey having become ſtrongly acid intenſely reddens the blue vegetable colours, we no longer obtain this matter from it by evaporation and cryſtallization.

41. Scheele not having been able to ſucceed in ſeparating the acid of ſour whey by diſtillation, but having obtained by this operation only a little acetous acid, the formation of which appears conſtantly to accompany that of the lactic acid, endeavoured to obtain this fixed acid by other means. The following is that which ſucceeded the beſt with him, and which, though complicated, proves the ſagacity and extenſive reſources of this able chemiſt. Sour whey is evaporated to an eighth of its volume

by a very gentle fire; it is filtrated in order to ſeparate from it all the caſeous matter thus coagulated in flakes; lime water is added to precipitate the animal earth, that is to ſay, the phoſphate of lime; it is then diluted with thrice its weight of pure water, and the exceſs of lime is precipitated from it by the oxalic acid, the latter being added in no larger proportion than is neceſſary, and ſo that an addition of lime-water ſhall form in it neither cloud nor ſtreaks; the liquor is evaporated to the conſiſtence of honey, alcohol is then poured into it, which ſeparates the portion of ſugar of milk or other extraneous matter, and diſſolves the lactic acid; laſtly, the liquor being drawn off clear is diſtilled till all the alcohol that has been added is collected: and what remains in the retort is pure lactic acid. The following are the ſpecific and charactereſtic properties which the Sweediſh Chemiſt has found it to poſſeſs.

42. It has a rather ſtrong ſour taſte which is not agreeable; it is in the liquid and viſcid form when concentrated; it reddens the tincture of turnſole well, and it gives a violet-red tinge to the ſyrup of violets. Evaporated even to a very denſe conſiſtence, it does not aſſume either the cryſtalline or granulated form; but it has a muciliganous viſcoſity. Diſtilled in a retort, it affords a pretty ſtrong empyreumatic acid analogous to the pyrotartarous, with very little oil, and the carbonic acid and carbonated hidrogen gaſes, and a coal in little abundance adhering to the glaſs,

glaſs. When united with the three alkalies, with barites and with lime, it forms ſalts little cryſtallizable and deliqueſcent. Its combination with magneſia cryſtallizes, but it alſo attract the moiſture of the atmoſphere: moſt of theſe earthy and alkaline lactates are ſoluble in alcohol. The lactate of ammonia is not known, neither are thoſe of alumine, of glucine and ſtrontian; what Scheele has given us relative to the properties of theſe ſalts is ſtill only a firſt notion. We find in it nevertheleſs relations with that of the acetites: however the lactic acid decompoſes the acetites.

43. The combinations of the lactic acid with the metallic oxides have alſo occupied Scheele; but he ſtudied only what appeared to him to be neceſſary for diſtinguiſhing and characterizing the lactic acid, and he had not the intention of examining their complete ſeries: ſo that his work preſents in this reſpect only a ſlight outline of what the ſcience requires. According to his enquiries, the lactic acid does not in any manner attract cobalt, biſmuth, antimony, mercury, ſilver and gold, notwithſtanding the long duration of contact between theſe bodies and even with the aid of ebullition. Zinc and iron are oxided and diſſolved in it, as in almoſt all the acids, with diſengagement of hidrogen gas: which announces that they decompoſe the water, that the lactic acid augments their attraction for the oxigen, that it favours and accelerates the decompoſition of the water,

and that theſe two metals contract no adheſion with it till after they have previouſly been oxided. The lactate of zinc cryſtallizes; that of iron forms only a brown deliqueſcent maſs. The ſame acid oxides and diſſolves lead and copper. Frequently, during the ſolution of the firſt of theſe two metals, a ſmall quantity of ſulphate of lead is precipitated, which announces the preſence of a ſmall quantity of ſulphuric acid in this acid.

44. We ſee, according to this faithful expoſition of the labours of Scheele upon the acid of ſoured whey, how much is ſtill wanting of facts in order to make us thoroughly acquainted with its properties: thoſe which he has deſcribed are merely ſufficient to prove that it is a particular acid different from all others. Beſides the great number of its ſaline compounds which are ſtill wanting to the ſcience, Scheele has not indicated the action of fire upon this acid, its ſpontaneous alteration in the air, its habitudes with the nitric acid, &c.: it is not known whether it is totally decompoſed by the latter or converted into another acid, eſpecially the oxalic, as ſeveral vegetable acids are. Its intimate nature and compoſition are entirely unknown: though it preſents properties which approximate it to the acetous acid, and which may lead us even to believe that it is very ſimilar to it, I ſtill find it impoſſible to rank it amongſt the vegetable acids. On the other hand, I find it equally impoſſible to adopt a decided opinion

relative to its animal nature, ſince no experiment has hitherto exhibited the preſence of azote in it, and ſince it is unknown whether it can afford ammonia in its decompoſition, whether it is putreſcible, whether it can be converted into Pruſſic acid, as we know can be done with all the well characterized animal matters. It muſt therefore be a ſubject of reſearch for chemiſts, if they wiſh to acquire a more poſitive knowledge concerning it.

45. It may be inferred from all the facts contained in this paragraph, form all the analytical experiments upon the ſerum of milk or whey, of which I have juſt given an account, that this liquid is compoſed of a large quantity of water, of a variable proportion of mucoſo-ſaccharine cryſtallizable matter, of gelatin and of ſome ſaline matters, eſpecially muriate of pot-aſh, perhaps of ſulphate of pot-aſh and phoſphate of lime; that the two firſt ſubſtances render it ſweet, ſaccharine, ſuſceptible of fermentation, of aceſcence, of affording nouriſhment, of cryſtallizing, of concreting into a jelly, of being precipitated by tannin; that the ſalts, and eſpecially the phoſphate of lime are the cauſes of its precipitation by the alkalies, of the traces of phoſphorous which its metallic precipitates treated by an intenſe fire yield; that the knowledge of theſe conſtituent materials explains its nutritive quality and its ſpecial advantage as the firſt aliment of young animals; that this compoſition of the ſerum of milk may be regarded with reſpect to it two

moſt abundant principles, the mucoſo-ſaccharine ſubſtance and the gelatin, as the natural link which contributes to hold a ſlight combination with the other materials of the milk, and eſpecially the butter; finally, theſe two matters perform in ſome meaſure the office of the gum in loches, or of the mucilages in the emulſions of vegetable ſeeds.

SECTION V.

Of the Caſeous Matter and of Cheeſe.

46. THE caſeous part of milk is obtained by means of a great number of different ſubſtances which have the property of turning or coagulating it. In order to obtain this ſubſtance pure, we muſt be careful to take ſkimmed milk, that it may not be mixed with butyraceous matter. Runnet, the flowers and the receptacles of moſt of the compoſite or ſyngineſian plants, and all the aſtringent plants, have the property of curdling or coagulating milk in the cold with the aid of a little time; the acids, whatever they may be, have the ſame property; and as they remain diſſolved in the ſerum, we may employ them, provided we uſe them weak and in ſmall quantity, for obtaining the caſeous part. We may alſo employ the dried membranes of the ſtomach and inteſtines of animals, glues,

jellies, and membranes, which produce the ſame effects. We have already ſeen that alcohol alſo acts in the ſame manner in the decompoſition of milk. The caſeous ſubſtance is ſeparated, either in the form of ſmall inſulated flakes, or in that of a kind of tremulous matter in a ſingle white and opaque piece, or in that of thick maſſes which tend to condenſe and harden.

47. In dairies the milk is turned by different means, but eſpecially by runnet employed cold, for preparing cheeſe. Theſe are in general of two kinds accordingly as they have been prepared either with entire or pure milk, or with ſkimmed milk. The firſt conſtitute the fat unctuous cheeſes, which retain a ſoftneſs and opacity, which have a fine and ſweet paſte, and by a ſlight alteration run and form a ſort of thick ſyrup, as we ſee in the good cheeſes of Brie. Skimmed milk affords a hard and ſolid caſeous maſs, which becomes dry and brittle, and, when ſtrongly compreſſed acquires a ſemi-tranſparency and conſtantly preſerves its ſolidity, growing hard inſtead of ſoftening and running. In order to fabricate and preſerve them they are put to drain upon hurdles, they are ſalted and kept in low and moiſt ſituations, they are ſometimes incloſed in hoops of thin and flexible wood or bark, which are bended round their ſides and cloſed every day ſo as to diminiſh their diameter ; they are alſo ſalted at their ſurface. By theſe proceſſes the water of the caſeous matter is preſſed out, its flakes

are brought nearer together, and they are made to acquire a homogenous conſiſtence throughout their whole continuity.

48. There are many differences in cheeſes, according to the diverſities of the milk, the nature of the runnet which is employed for ſeparating and precipitating them, the art of preſſing, kneading, draining, drying and expoſing them to different degrees of alteration or of fermentation; according to the quantity of whey which is left in them, the force of preſſure which is employed, the temperature to which they are ſubjected, the kind of package or piling which they undergo, the time during which they are treated in this manner; laſtly, according to the general combination of all the circumſtances which preſide in ſome reſpect over their preparation. In order to obtain cheeſes with a dry, denſe, ſemi-corneous and ſemi-tranſparent paſte, like thoſe of Gruyere; the caſeous matter being ſeparated from the coagulated milk is kneaded in the hands: after it has been properly worked, it is drained upon hurdles or compreſſed and kneaded anew; the cheeſes are preſſed and the ſerum forced out of them, not only moveable by the hoops which are brought cloſer every day, but alſo with weights placed upon them after they have been piled one upon the other; when once dried they are ſalted at ſeveral times; the white and blue mould which forms upon their ſurface

is repeatedly ſcraped off; this is diſcontinued when this mould formed upon the dried rind has aſſumed a red colour; the fermentation is conducted ſlowly and gently till it has communicated to the cheeſes the taſte and ſmell which ought to charaſterize them. This operation is performed in ſubterraneous buildings, or cool vaults, and at a conſtant temperature of between 2 and 5 degrees + 0. Such are the ſo famous cheeſes of Roquefort.

49. It is not upon theſe cheeſes prepared by art and more or leſs altered by a fermentation which none of them eſcapes, and which is conſtantly obſervable in all or almoſt all theſe alimentary preparations, that chemiſts make the experiments proper for aſcertaining the properties. It is to this matter in its freſh ſtate, not altered but ſtill natural, ſuch as it is precipitated from the milk at the very moment of its decompoſition, that they direct their attention, and upon which they perform their experiments. The caſeous ſubſtance, which is not yet cheeſe, obtained in this manner and well preſſed, is in the form of white granulated flakes, eaſily ſeparable from each other, ſuſceptible however of being cruſhed under the finger like a ſort of paſte, of a ſweetiſh taſte which is not diſagreeable. It powerfully retains the laſt portion of ſerum lodged between its interſtices, and a great degree of preſſure is requiſite in order to dry it completely; it is then denſe, brittle, and begins to aſſume a ſemi-tranſparency: in this

ſtate its aſpect preſents the notion of a concrete albuminous ſubſtance. The average quantity of the caſeous ſubſtance is eſtimated at $\frac{1}{16}$ of the entire milk. There are great varieties in this proportion,

50. The caſeous matter, well condenſed, kneaded and deprived of all the ſerum by preſſure, and well ſeparated from the butyraceous ſubſtance, in conſequence of being extracted with care from ſkimmed milk, expoſed to a gentle fire gradually augmented, ſoftens, becomes ropy, and as it were glutinous and elaſtic; if acted upon by a ſtronger fire it entirely melts, ſwells, becomes brown, exhales a thick fume of a very fetid and ſtrongly ammoniacal ſmell, and at laſt takes fire, flaſhes of white and brilliant flame eſcaping from ſeveral points; it leaves a pretty denſe coal. If we diſtil it in the retort, we obtain a red, turbid and fetid water, charged with zoonate and carbonate of ammonia, a very thick oil, almoſt concrete, of a deep brown colour and of an inſupportable ſmell, concrete ammoniacal carbonate ſoiled by a little oil, much carbonated and ſulphurated hidrogen gas, with carbonic acid gas, and a hard coal, adhering to the glaſs, brilliant, difficult to be burned, the aſhes of which preſent in analyſis only a little muriate of ſoda, and the greater part phoſphate of lime. No carbonate of ſoda or metallic oxide is found in it.

51. Expoſed to the air in its dry ſtate, the caſeous matter remains and is preſerved without

out alteration; but if it retains a portion of ſerum between its parts, it firſt turns ſour at a temperature exceeding 12 degrees; it afterwards putrefies, ſoftens at its ſurface; there flows from it a kind of fetid ſanies; ammoniacal gas is diſengaged from it, and inſupportable fetid odour, that ſubſiſts for a very long time, very tenaceous and which appears to be owing to a compound gas, that eſcapes but very ſlowly and with much difficulty; it paſſes at the ſame time through ſeveral ſucceſſive tinges, orange, red, brown, blue, &c. Every one knows the horrible infection diffuſed by old or putrefied cheeſe, and the adheſion, the kind of fixity which this odorant ſubſtance acquires upon different bodies, the wood-work and even the walls which are impregnated with it. The total decompoſition of this ſubſtance is of a very long duration, and it preſents, like the fleſh and other animal ſuſtances already indicated, a fatty and very fuſible body, reduced to an ammoniacal ſtate by the ammonia, the complete deſtruction of which laſts for a great length of time: the contact of water in abundance abridges its duration.

52. Cold water ſcarcely diſſolves cheeſe at all; it holds its moſt divided flakes for a longer or ſhorter ſpace of time in ſuſpenſion; boiling water, without really diſſolving it, ſoftens it and contracts a pretty ſtrong adheſion with it. Scheele has obſerved that the caſeous ſubſtance,

precipitated by an acid foreign to the milk, is partially ſoluble in boiling water; but this ſolution does not ſucceed unleſs it be effected at the very moment when the ſubſtance has juſt been precipitated: if we leave its flakes for ſome time to unite and condenſe, it is no longer poſſible to accompliſh it. When the caſeous matter has remained for a ſufficient time in cold water, we find it converted into a fat, unctuous, fuſible body, very ſoluble in the cauſtic alkalies and of a fetid ſmell. Water therefore accelerates the ſpontaneous decompoſition to which this animal matter is naturally ſo much diſpoſed. This is the reaſon why dry cheeſes, expoſed in moiſt places, ſoften, increaſe in weight, acquire a ſmell, a taſte, in ſhort a ſtate, different from what they had at firſt; it is in this manner that they are matured according to the common expreſſion, and thoſe qualities are given to them which are ſo much in requeſt amongſt perſons who prefer of this kind of food.

53. The powerful and concentrated acids act rather ſtrongly upon the caſeous matter, and diſſolve it eaſily with the aid of heat; but if diluted with water, or naturally weak, they do not by any means exert the ſame action upon it. The nitric acid turns it yellow, diſengages from it azotic gas, Pruſſic acid and carbonic acids, and changes it partly into fatty matter, partly into oxalic acid. There is alſo formed a ſmall quantity of bitter matter, which adheres

in a great meaſure to the yellow oil and which colours the fingers.

The cauſtic alkalies, in highly concentrated leys, alter the caſeous matter at the very moment of their contact; and ſeparate from it azote and hidrogen, which immediately unite into ammonia, and they convert its reſiduoual portion into a kind of oil with which they unite in the ſaponaceous ſtate. Ammonia diſſolves the caſeous matter rapidly and abundantly when recently precipitated or coagulated, and this ſolution is conſidered as one of the moſt ſpeedy and powerful. Quick-lime forms with this matter, when ſtill humid, a kind of paſte ſuſceptible of great ſolidity and adheſion: this mixture is employed as one of the beſt cements for porcelain. There is reaſon to believe that a ſtill more ſolid cement might be made with barites and ſtrontian.

54. The ſalts have not the ſame ſolvent action upon the caſeous matter, but almoſt all of them oppoſe its ſpontaneous decompoſition; accordingly the muriate of ſoda is more eſpecially employed both as a means of preſervation and as ſeaſoning, in order to make the cheeſes keep, and to retard the ſeptic alteration which tends to deſtroy them. An old prejudice, which I have already combatted, has cauſed it to be aſſerted that the ſmall quantity of this ſalt accelerates their fermentation; but it is eaſily found by obſervation that it is not with the intention of favour-

ing it that this ſaline condiment is employed, but rather with that of limiting it, by covering the ſurface, by abſorbing their humid portion, by concentrating their commencement of their ſeptic alteration in their centre, or confining it to their exterior part, according to the ſoft or ſolid nature of theſe preparations. The ſame is the care with the oxides and eſpecially the ſalts of metals, which condenſe, contract, dry, and conſequently preſerve the caſeous matter, either by the approximation of its molecules, or by abſorbing its humidity, or by preſerving it from the external moiſture.

55. Many vegetable ſubſtances are ſuſceptible of uniting with the caſeous matter when freſh, ſoft and humid; it is rendered miſcible with water by triturating it with mucilages; it adheres to the ſaccharine ſubſtance; it becomes charged with ſeveral colouring matters; it unites by trituration with the fecula; it combines with tannin, and becomes hard and dry in this tanned combination. Its habitudes with the animal ſubſtances are as yet not well known; no attempt have yet been made to determine its relations with the albuminous and gelatinous liquors, with the fat juices, with fibrine, with the moſt complicated animal liquors, though it is eaſy to be conceived that inquiries of this kind might procure an acquiſition to animal philoſophy, by aſcertaining the miſcibility, the ſolubility, the re-action and the reciprocal alteration which thoſe different

organic compounds may preſent amongſt themſelves. It is very evident that this caſeous ſubſtance is intimately mixed with the butyraceous oil and the gelatin in milk, and that it is to theſe ſubſtances that owes its ſolubility or adheſion with water, which forms the vehicle of the different materials of this liquid.

56. All the lights that have been acquired relative to the properties of the caſeous ſubſtance have induced modern chemiſts to think that this ſubſtance has a remarkable analogy with albumen; and in fact it is amongſt the different animal materials that which the caſeous ſubſtance reſembles the moſt in its coagulation by the fire and by the acids, its ſolubility in ammonia, its products in diſtillation, or its alteration by the nitric acid. But notwithſtanding this analogy, there are however ſome remarkable differences between the albumen of the blood and the caſeous ſubſtance, which indicate, that though the latter proceeds from the blood, it has undergone in ſeparating from it, and in order to aſſume the milky form, a modification which has not yet been appreciated. Citizens Deyeux and Parmentier believe that it is to the caſeous ſubſtance that the milk owes its opaque whiteneſs, and not to the oily particles ſuſpended by its combination with them, that it is conſequently inaccurate to compare milk to an emulſion. If they poſſeſs facts in ſupport of this new mode of conſidering the union of the caſeous part with

the water, we ſhould ſee in the opacity of this ſolution a ſufficiently demonſtrative indication of a more advanced oxigination in this ſpecies of albumen of the cheeſe, than in the other known ſpecies of this animal matter. We ſhould even find here a rather ſingular analogy between the caſeous albumen whitening water by its ſolution and the cerebral albumen which dilutes in it, partly diſſolves in it, and equally gives to water the emulſive appearance.

Rouelle the younger has eſtabliſhed a marked analogy between the caſeous matter and the glutinous ſubſtance of the flour of wheat; he ſucceeded by ſalting and kneading the latter with muriate of ſoda and a ſmall proportion of diluted ſtarch, in giving to the farinaceous glutin moſt of the characters, the taſte, the ſmell, the unctuoſity of cheeſe, and he exhibited in his lectures ſpecimens, which by this preparation, had acquired the properties of old cheeſe in ſo characterized a degree that it was no longer poſſible to diſtinguiſh them from it.

SECTION VI.

Of the Butyraceous Matter, and of Butter.

57. I DISTINGUISH the butyraceous matter from butter, becauſe the firſt, being contained in the milk at the moment when it is formed, is not yet butter, and becauſe this laſt exiſts only when the milk has remained for ſome time at reſt after having been drawn from the animal which affords it. It is with this ſubſtance relatively to theſe two ſtates as with the caſeous part and cheeſe: the firſt, being contained ready formed in the milk, may be ſeparated from it without intimate alteration; but it becomes cheeſe, as we have ſeen, only by undergoing a more or leſs conſiderable modification and change, from even the freſheſt cheeſe to that which is the moſt advanced or the neareſt to its putrid decompoſition. Butter preſents in its ſeparation and formation a ſtill more conſiderable difference from the milky ſtate than the caſeous matter does, at leaſt as far as concerns its mere precipitation from the milk. It is upon this remarkable point in its hiſtory that I ſhall firſt dwell, as it has not yet been properly treated by the chemiſts who have gone before me. In 1790, I publiſhed, according to a ſeries of experiments

made in the courſe of the lyceum of this year, a new point of theory, relative to the formation of butter. I remarked that the cream was formed more abundantly in the air than in cloſe veſſels and in vacuo; that it was neceſſary it ſhould remain expoſed to it for ſome time, in order to render it capable of affording butter; that butter could not be extracted from recent cream; that in proportion as it remained in the air, it became more ſolid, condenſed, and aſſumed a yellow colour; that it required at leaſt four times longer ſpace of time to ſeparate the butter from cream formed in twenty-four hours, than to extract it from cream eight days old; and that all this proved an action of the air, which contributes to the formation of the butter, to its concretion, and ſeparation.

58. The production of the butter is to be underſtood in the following manner, according to the conſtant facts well known in all dairies and farms. The butyraceous matter, contained in the milk in the ſtate of a liquid, and white oil, ſuſpended in the ſerum, with the aid of the mucoſo-ſaccharine body, and of the caſeous ſubſtance, ſeparates, by means of repoſe, and ſwims at the ſurface, with a ſmall portion of ſerum, and of caſeous flakes, to which it adheres. This compound, which is more oily and more light than the ſerous and caſeous liquor, in proportion as it obtains the contact of the air by remaining above this liquor, abſorbs the atmoſpheric oxigen, becomes ſolid, concrete,

coloured; in ſhort, real butter. However, butter may be prepared with milk newly drawn, by agitating it for a long time; whence I conclude, that there is in the milk a ſufficiency of oxigen to ſaturate the butyraceous matter by this percuſſion. On the other hand, there are ſome creams, from which butter cannot be extracted by churning them for a great length of time, and which we are obliged to abandon as to that purpoſe. In general the cream is left expoſed to the air for five or ſix days before the butter is churned; and in the great rural eſtabliſhments, this operation is performed only twice every decade: there are many varieties in the properties of milk, relative to the quantity and the quality of the butter which it affords, and ſtill more particularly with reſpect to the facility with which the butter ſeparates from it. A connected ſeries of obſervations, and ſome ſingle experiments, would be requiſite, in order to determine the cauſe of theſe varieties.

59. Chance firſt preſented the ſeparation and concretion of the butter in agitated milk: the ſkins in which the Tartars, and the paſtoral nations tranſport their milk, whilſt they inceſſantly change their abodes, and wander in the deſarts with their beaſts, muſt have exhibited to them this product concreted into ſolid lumps by agitation and percuſſion againſt the ſides of theſe veſſels; and the agreeable taſte of this product muſt have recommended its uſe, and

dictated to them the art of providing themſelves with it; accordingly, we find traces of it in the moſt remote antiquity, which are loſt even in the firſt traditions of the human race. The mode of churning the cream, or the butter, varies according to the countries, and the quantity of it that is fabricated: it is in general by turning or moving with rapidity, an axis provided with fans, or kinds of agitators, in veſſels more or leſs capacious, which are in part filled with cream. They are kinds of churns; the former fixed horizontally, the latter placed vertically, which ſerve for the operation. During a percuſſion, or rotation of ſome hours, the motion of the axis, and of the fans which it bears, after having been gradually impeded, is ſuddenly ſtopped by the maſs of butter which adheres to it, and attaches itſelf entirely to it. This maſs is afterwards kneaded in water, in order to ſeparate it accurately from the portion of whey and of caſeous flakes, which are interpoſed in it.

60. We ſee from this deſcription, that butter is obtained from the milk but ſlowly, and by means of a long and violent agitation, which modifies the butyraceous matter, by cauſing it to abſorb a portion of the oxigen of the milk; that it is much eaſier to be prepared with cream, and that a much leſs conſiderable percuſſion then effects its concretion; that older the cream is, the more ſpeedily the operation is performed; that the butter does not

therefore exiſt ready formed in the milk; and that at the moment when it is ſaturated with the oxigen it requires, the butyraceous matter is converted into butter and quickly concretes into a maſs, which no longer adheres to the ſerous liquor of the cream, becauſe the attraction between its own particles is more conſiderable than that which it has for the other principles of the milk. When this production, and ſeparation of the butter have taken place, there remains a yellowiſh liquor, ſometimes of a ſlight orange colour, which is called butter-milk: it is more fluid than milk that has not been deprived of its cream, of a mild and agreeable taſte, altogether ſimilar in its nature to milk that has been entirely deprived of its cream. Citizens Deyeux and Parmentier have made a particular examination of it: they have found that butter-milk is coagulated by runnet with great difficulty, that the acids and alcohol ſeparate caſeous matter from it eaſily and ſpeedily in very fine flakes; and that it has a very great diſpoſition to turn ſour.

61. Butter, thus prepared, is generally of a yellow colour: there is ſome which is white, like a kid of fat; this is conſidered as inferior to the former. It is believed that this difference of colour depends upon the nature of the aliments; but it is well known to the country people, that it depends upon the diverſity of the individuals that afford the milk; that one cow will conſtantly give white butter, and another

other yellow butter. The contact of the air alſo influences the colouration of the butter; old cream affords yellow, and new cream paler butter. The lumps of butter expoſed for ſale, are of a deeper yellow colour at their external ſurfaces, than in their interior parts. Freſh butter has a ſweet and unctuous taſte, which is very agreeable, and on account of which it is employed as a ſeaſoner: the difference of the food of the animals has much influence upon this property of the butter. Its ſoft and very ductile conſiſtence, though in general it is concrete, varies alſo according to a great number of circumſtances. All the phyſical properties of butter are ſubject to vary according to the ſame circumſtances.

62. Very freſh butter melts at a temperature of 29 or 30 deg. Reaumur. When we keep it melted in a tube of glaſs, plunged in boiling water, there ſeparates from it, and ſwims at the ſurface, a white liquid, filled with ſmall opaque flakes, which are a mixture of ſerum of milk, and of caſeous matter. By this ſeparation, the butter becomes almoſt tranſparent; but it has then loſt its ſweet and unctuous taſte, and it has become fatty and inſipid: whence it reſults, that freſh butter owes its ſweet, agreeable taſte, to a portion of a ſerum, and of caſeous matter. Accordingly, melted butter, with whatever caution it may be prepared, becomes more greaſy, of a granulated conſiſtence, and of a

taſte infinitely leſs agreeable than that which it had before. If the butter has been heated only to the temperature neceſſary for melting it, it fixes as it cools, and preſents no ſigns of alteration. When diſtilled in a ſmall retort, it affords ſome drops of water, rendered acrid by the ſebacic acid which it contains: the greater part of the butter riſes and paſſes over entire, with a ſtrong pungent, and very diſagreeable ſmell, as we ſee in culinary operations, where ſo many diſhes are prepared with browned or ſcorched butter; much carbonated hidrogen gas is diſengaged, and there remains only ſome traces of a denſe coal, difficult to be burned, and containing ſcarcely any thing elſe than a little phoſphate of lime. By re-diſtilling the products of the butter, we render the oil lighter and more volatile. If we diſtil it in a very large veſſel, containing much air, we obtain more water, more ſebacic acid, a leſs concreſcible oil, more of gaſeous fluid, and more coal, ſince the air of the apparatus contributes to the deſtruction of the butyraceous matter by furniſhing its hidrogen with a quantity of oxigen ſufficient for burning it. The ſebacic acid is not contained in the butter but is formed here, as in diſtilled fat, at the expenſe of its decompoſition, and of another arrangement of its principles.

63. Butter ſuffers from the contact of hot air, an alteration which renders it acrid and odorous. This rancidity proceeds from the

formation of ſebacic acid, which takes place with conſiderable celerity. Waſhing with water, and with alcohol, deprives the butter of a great part of thoſe diſagreeable properties.

Butter unites by fuſion with phoſphorus and with ſulphur, in the ſame manner as fat does.

The acids likewiſe act upon it in the ſame manner; the concentrated ſulphuric turns it brown, and reduces it to coal; the nitric yields to it a portion of its oxigen; the others have no action upon it.

The alkalies diſſolve it very well; ſoda forms a ſolid ſoap with butter, which might be employed with advantage in medicine. Barites, ſtrontian, and lime, harden it by combination. Ammonia, alſo, approaches it to the ſaponaceous ſtate, but leaves it liquid. The ſoaps of butter, when burned and calcined, afford alkaline, or earthy ſebates, like fat: and theſe ſebates are alſo produced by the action of the fire.

The metallic oxides unite with butter, by the aid of fire, and form with it metallic ſoaps, little or not at all ſoluble, of a plaſtic conſiſtence. In the heat it decompoſes the metallic ſolutions, and takes from them, eſpecially from the nitrates, the oxides with which it combines.

64. Amongſt vegetable ſubſtances, butter unites with the extracts; the gums, and ſugar, triturated with it, render it miſcible with water; it combines eaſily by fuſion with the reſins, the gum-reſins, and the balſams; it diſ-

ſolves eaſily in the fixed and volatile oils; it abſorbs camphor, and retains it ſtrongly; it attracts ſeveral colouring matters, with which it adheres forcibly. The laſt-mentioned property has long been employed for giving butter a more or leſs intenſe gold colour; for this purpoſe, carrots, the curcuma, the marigold, the ſeeds of aſparagus, the berries of ſolanium kalicacabum are uſed. The colours of butter may be greatly multiplied, and ſingularly varied. The root of the alkanet gives it a brilliant roſe colour, the violet a dull, but pretty intenſe blue; the leaves of ſpinnage, a brilliant green colour. The proceſſes conſiſt in mixing the colouring matters, pounded or chopped, with the cream before it is churned; the colour thus paſſes into the butter at the moment when it becomes concrete, but not before this period. Butter, coloured in this manner, keeps for a long time; it is even difficult to diſcolour it. We may alſo cauſe theſe different colours to paſs into the butter by means of fuſion; but butter, coloured in this manner, cannot ſerve for a ſeaſoning. The highly odorous matters unite with butter with facility, and we may perfume it by their mixture at the moment when it is churned, with cinnamon, cloves, nutmeg, mace, orange or lemon peel, vanilla, &c.; but very little muſt be uſed, in order to communicate to it a perfume, without acrimony.

65. It may be concluded from all that has

been ſtated, that butter is a kind of concrete and oxigenated oily humour, reſembling fat, and not a vegetable oil, united with an acid, as was formerly believed; that this ſubſtance, without being entirely conſtituted butter in the milk, has, however, a great diſpoſition to become ſuch, and to ſeparate from this liquor in proportion as it abſorbs oxigen from the atmoſphere, when milk, and ſtill better when cream, is agitated in contact with the air; that butter, which owes its qualities as freſh butter to the mixture of a ſmall portion of ſerum, and of the lighteſt caſeous matter, and loſes them by the ſlighteſt fuſion, comports itſelf afterwards like a kind of fat, in all combinations, as well as in all the analytical proceſſes to which it is ſubjected; and that laſtly, there is reaſon to believe, according to theſe chemical phenomena, as well as from the anatomical obſervations of the celebrated Haller, that the fat which every where ſurrounds the mammary glands, contributes, by means of the ducts deſcribed by this great anatomiſt, to the formation of milk, probably by furniſhing it with the baſis of the butyraceous matter, whilſt the lymph gives it the mucoſo-ſaccharine principle; and the blood, the albumino-caſeous ſubſtance, as well as the ſalts which are diſſolved in it.

SECTION VII.

Of the different Kinds of Milk, compared with that of the Cow.

66. In the general examination of milk, and of its different parts, which has hitherto formed the object of this article, I have taken the milk of the cow as an example, as a mean term of all theſe kinds of animal liquors, as that which is moſt frequently employed, and for the greateſt number of uſes, becauſe it is procured more abundantly, and more eaſily than any other. But it is equally uſeful, and even neceſſary for many circumſtances of life, to know the characters and the nature of the other kinds of milk which are employed, either often, or only ſometimes, as aliments, or as medicines, or as objects of rural manufactures, and the ſubjects of products advantageous to whole countries. We muſt therefore compare together the milkof woman, and thoſe of the aſs, the goat, the ewe, and the mare; all of which, when referred to what I have ſaid concerning the milk of the cow, will require nothing more than the ſimple expoſition of their differences. Moſt

of the authors quoted in the beginning of this article, have ſpoken more or leſs concerning thoſe differences; but none have made them the object of more attention and ſtudy than citizens Deyeux and Parmentier. I ſhall therefore more eſpecially follow them in giving the ſpecific characters of each kind of milk, attending, like them more to the quality than the quantity of their principles; becauſe the latter, varying according to a multitude of circumſtances, preſent nothing conſtant to the obſerver.

A. *Woman's Milk.*

67. The milk of the woman is generally known to be leſs thick, leſs opaque, and more ſaccharine than that of the cow. Its coloſtrum frequently reſembles thin ſoap water; repoſe, cauſes fat and unctuous flakes to ſwim upon it, from which no butter can be extracted by agitation. The liquor, after this ſeparation, is ſcarcely opaque, becomes viſcous, ſour, putrefies, and appears to contain little caſeous matter: ſuch is the coloſtrum of the firſt day. That of the ſecond, which is whiter, affords a kind of flakey cream, which does not yield butter any more than the preceding; that of the third and of the fourth day aſſumes the character of real milk, ſtill without the poſſibility of extracting butter from its cream: the acids coagulate it well, and its ſerum is eaſily clarified.

The well-formed milk, examined at different periods till the eleventh month after lying-in, preſents varieties, even at different times of the day: it, however, gradually diminiſhes in quality, in general, proportionably to the length of time that has elapſed ſince delivery. Its cream, which is very abundant, ſometimes does not admit butter to be ſeparated from it; it is then very liquid, unctuous, and ſeems to contain an oil that is not concreſcible.

68. When the cream of woman's milk is thick, it affords by agitation firm butter, a little yellowiſh, of an ordinary taſte, and in ſmall quantity. All the proceſſes which coagulate the milk of the cow, produce the ſame effect upon that of woman; the cheeſe is in general ſoftiſh, unctuous, and does not acquire the ſame concrete ſtate. The clarified ſerum is ſcarcely coloured, its taſte is more ſaccharine than that of cow's milk; it contains only a little more of the mucoſo-ſaccharine principle; Haller, however, has indicated its proportion to that of the cow, according to Navier, Hoffman, and Yonna, as 67 to 54. This ſerum is leſs compounded than that of the cow, it contains leſs ſalts, and it is to this circumſtance that citizens Deyeux and Parmentier attribute its more ſaccharine taſte. There is no milk that ſhows itſelf more variable in its analyſis than that of woman. Upon the ſlighteſt change in the ſtate of the health, it loſes its conſiſtence;

after ſpaſms it contains no more caſeous matter; it is then repugnant to the infant, who does not take the breaſt again till when the milk has returned to its natural ſtate. Thin and delicate women frequently yield ſtronger and more abundant milk than fat women. It is known with what facility the medicinal, and particularly the purgative properties, paſs from nurſes to their ſucklings; this is much more remarkable in women, than in the female animals.

69. Citizens Deyeux and Parmentier have examined even the differences which ariſe from the different methods of ſuckling the infants. According to their obſervations, great inconveniences ariſe from making them ſuck often, and letting them take only a ſmall quantity of milk at a time: it is then always too ſerous. Women, who without being aware of this, and in order to mitigate the cries of their infants, acquire the bad habit of giving them ſuck very often, and thus afford them always a too liquid or ſerous milk, in ſmall quantities at a time, are much more ſubject than others to repletions of the breaſts, and all the affections which depend upon the alteration and detention of this liquid in the mammary ducts. It appears that a phenomenon here takes place analogous to that which is obſerved in milking cows at divided periods; it has been ſeen that the firſt milk is the moſt ſerous, the leaſt thick, and the leaſt fat; and that its properties regularly

improve to the laſt ſtage of milking; in this manner it is that milk-women procure creamy milk. It will therefore be attended with great advantage, both to the infant and the mother, to let the infant ſuck only at ſtated periods ſufficiently remote from each other, in order that the homogenous milk may be entirely drawn out by the ſuckling, whoſe deſire for it is then greater, and who exhauſts the breaſt more completely.

B. *Milk of the Aſs.*

70. The ſhe-aſs, when well fed and attended, affords milk always more fluid than that of the cow, the conſiſtence of which more reſembles that of the woman. It is in general not very palatable; it conſtantly affords a white ſoft butter, very liable to rancidity. Runnet, the acids, and all the well known means coagulate the aſſes' milk; its coagulum is commonly in a magma, one part of which floats upon the ſurface of the liquor, whilſt another is precipitated. The ſerum is very eaſily clarified. It has not more, or very little more colour than that of woman's milk; it is a little leſs ſaccharine than the latter, but ſenſibly more ſo than the whey of cow's milk. Haller, however, indicates for the quantity of the mucoſo-ſaccharine ſubſtance

contained in aſſes' milk, a greater proportion than for that of the woman. This proportion, according to him, is as 82 to 67; ſo that this liquor appears to be that which, of all, contains the moſt ſugar of milk. Citizens Deyeux and Parmentier aſſure us, that by examining comparatively the milk of three aſſes, they found many varieties in the ſerum which they obtained from it. It appeared to them to contain the ſame ſalts as that of the cow, but in ſmaller quantity.

C. *Goat's Milk.*

71. The milk of the goat is the thickeſt of all, according to the ſame chemiſts. It has a ſmell which is diſagreeable to ſome perſons, but which may be diminiſhed by attention and cleanlineſs in the feeding of the animal: that of white goats is leſs odorous than that of black ones. It affords much cream, and this yields much butter. The butter of goat's milk is white, it acquires much ſolidity, and keeps for a long time without becoming rancid. The ſame milk alſo contains much caſeous matter, which is eaſily ſeparated from it by all the well known means. It is obtained in the form of a very denſe, very thick curd. The ſerum of this milk may afterwards be well clarified; it is generally yellowiſh, with a greeniſh caſt. Ac-

cording to Haller, the proportion of the ſugar of milk contained in it, with relation to that of cow's milk, is as 42 to 54; and according to citizens Deyeux and Parmentier, it does not contain leſs of it than the latter: but what has appeared to them very remarkable is, as they aſſert, that they found in it only muriate of lime, after having extracted from it the mucoſo-ſaccharine matter. We ſhould be led to believe that the phoſphate of lime ought alſo to be abundant in it, from the thickneſs, the hardneſs, and the length of the hair of this animal, upon the nature of which, this ſalt has much influence, as I have already indicated in the article concerning the analyſis of the hair.

D. *Ewe's Milk.*

72. Though at firſt ſight this is little different in its aſpect from the milk of the cow, it preſents, however, in the analyſis, eſpecially in that made by citizens Deyeux and Parmentier, well-marked characters which diſtinguiſh it. It affords a cream which is abundant, but has little thickneſs, from which is ſeparated a ſoft very fuſible butter, of the conſiſtence of a fixed oil, of a very pale-yellow colour, which eaſily becomes rancid. Its caſeous matter is fat and viſcid; its ſerum, which in general is difficult to be clarified, eaſily yields ſugar of milk almoſt

pure from the firſt cryſtallization, according to the above-mentioned chemiſts. It is, however, of all kinds of milk, that which, according to the authors collected and compared by Haller, affords the leaſt of this mucoſo-ſaccharine ſubſtance; its proportion to that of the cow is as 37 to 54. The ſerum, after the extraction of this ſubſtance, contains muriate of lime in very ſmall quantity, according to citizens Deyeux and Parmentier.

The moſt remarkable difference, or the moſt prominent character of the milk of the ewe, conſiſts in the properties or conſiſtence of its caſeous part: its viſcid and ſoft ſtate is the cauſe of the fatty conſiſtence which the cheeſes prepared with it conſtantly preſent. On this account, it is the practice in ſome countries to mix ewe's milk with the milk of the cow and the goat, in order to give to the cheeſes which are fabricated there, a more unctuous and marrow-like quality, and a ſofter paſte, which does not dry without difficulty

E. *Mare's Milk.*

73. This is the moſt fluid milk of all that have been mentioned. It has hardly any ſmell or taſte. The ſmall quantity of cream which it affords is very liquid, yellowiſh, and furniſhes only, with difficulty, a ſmall quantity of bad-conditioned butter; it ſeems that the caſeous

matter, which is difficult to be ſeparated from this milk by the vegetable acids, remains adhering to the butter, for there remains a portion of it diſſolved by theſe acids, as well as by the ſerum. However, this is eaſily clarified, and ſugar of milk obtained from it by evaporation.

According to the extracts compared by Haller, mare's milk is the ſecond in the order of the milks, with reſpect to the quantity of ſugar which it yields; it follows immediately after aſſes' milk, and ſtands in the interval between this and the milk of women. The proportion of this mucoſo-ſaccharine principle, relatively to that which cow's milk preſents, is, according to this celebrated phyſiologiſt, as 70 to 54. It is known, that mare's milk, kept for ſome time, acquires an intoxicating quality, and it is in this milk that this property of vinous fermentation has firſt been obſerved.

F. *Materials of the different Milks compared with each other.*

74. By comparing, according to the details given relative to each milk in particular, the conſtant nature, more uſeful to be known than the variable proportion of the products extracted from them, the following reſults have been aſcertained by citizens Deyeux and Parmentier by their inveſtigations.

All the milks become covered with cream at their ſurface, but it varies in the different kinds of milk.

a. In the milk of the *cow*, it is abundant, thick and yellow.

b. In *human* milk, more liquid, white, in ſmall quantity.

c. In *goat's* milk, more abundant than in the milk of the cow, thicker, whiter, and eſpecially leſs aceſcent.

d. In *ewe's* milk, almoſt equally abundant and yellow as in that of the cow, but always diſtinguiſhable by a particular taſte.

e. In *aſſes'* milk, not thick, little abundant, frequently ſimilar to that of human milk.

f. In *mare's* milk, very fluid, ſimilar in colour and conſiſtence to good cow's milk, from which the cream has not yet ſeparated.

75. The butter, is always oily, ſweet, very fuſible, and has the following comparative properties.

a. Extracted from the cream of the *cow*, it is ſometimes very yellow, ſometimes pale, fequently white, and always conſiderably conſiſtent.

b. Difficult to be extracted from the cream of *human* milk, in ſmall quantity, inſipid, of a pale yellow colour, frequently inſeparable from the cream, which it renders unctuous; whence it has been erroneouſly inferred that this milk affords no butter.

c. The butter of *aſſes'* milk is always very white, ſoft, very ſubject to ſpeedy rancеſcence.

d. The butter of the *goat* ſeparates eaſily from the cream, is very abundant, always white, firm, ſoft, and rancеſcible.

e. The butter of the *ewe*, is rather yellow, always ſoft, conſiderably ſubject to rancidity.

f. The butter of *mare's* milk is difficult to be obtained in ſmall quantity, it does not aſſume conſiſtence unleſs by waſhing in cold water, and is much diſpoſed to rancidity.

76. The caſeous matter is alſo a conſtant product, one of the conſtituent materials of milk; it varies in the ſpecies in the following manner.

a. That of the *cow* is voluminous, tremulous, ſeemingly gelatinous, very abundant, retaining much ſerum which is made to flow out by a ſlight preſſure.

b. That of *woman's* milk is little abundant, without coheſion between its particles, always unctuous and ſtringy, retaining but little ſerum between its particles.

c. That of the *aſs*, nearly ſimilar to the preceding, without unctuoſity.

d. That of the *goat*, in large quantity, in a thick coagulum, more denſe than the curd of cow's milk, retaining leſs ſerum.

e. That of the *ewe*, always fat, viſcid, difficult to be condenſed into curd, and giving a ſoft paſte to the cheeſes.

That

f. That of *mare's* milk little abundant and very ſimilar to that of human milk.

77. The ſerum conſtitutes in general the moſt abundant part of the milks; it varies in the different ſpecies as follows:

a. The clarified ſerum of *cow's* milk is ſometimes of a pale yellow, ſometimes of a greeniſh colour, containing ſugar of milk and ſalts.

b. That of *woman's* milk, is little coloured, of a very ſaccharine taſte, being the third, according to Haller, with reſpect to the proportion of the mucoſo-ſaccharine ſubſtance.

c. The ſerum of *aſſe's* milk is without colour, containing leſs ſalt and more ſugar of milk than that of the cow.

d. The ſerum of *goat's* milk is ſcarcely yellowiſh, a little ſaccharine, holding the laſt place but one with reſpect to the quantity of ſaccharine matter, with few ſalts, almoſt ſolely the muriate of lime.

e. The ſerum of *ewe's* milk is almoſt always colourleſs, of a faint, and as it were greaſy taſte, the leaſt charged with ſugar of milk, containing muriate and phoſphate of lime in ſmall quantity.

f. The ſerum of *mare's* milk is little coloured, the ſecond, according to Haller, with reſpect to the quantity of ſaccharine matter contained in it; according to Deyeux and Parmentier, charged with more ſaline matters than moſt of the other milks.

SECTION VIII.

Of the Uſes of Milk.

78. THE uſes of milk are extremely numerous and always of great importance. They may be conſidered under the fourfold relation of natural uſes, economical uſes, medicinal uſes and uſes in the arts. Under the three firſt of theſe relations this alimentary and medicinal liquid conſtitutes the opulence of ſeveral whole nations wiſe in their ſimplicity, and happy enough in what we call their barbariſm, to place their wealth in the abundance of their cattle, which furniſh them with what they require for ſatisfying all their wants. The paſtoral or erratic nations, who live almoſt entirely upon milk and its products, and the times in which a great number of thoſe which are now civilized derived from it their ſimple nouriſhment, recal to our minds thoſe happy days which the poets have depicted to us as the golden age, and it appears to the philoſopher who compares thoſe happy ages and people with thoſe of the preſent day, that the mildneſs of this aliment of the firſt inhabitants of the earth, muſt have had an influence upon the gentleneſs and amenity of the manners of antiquity.

79. By ſwelling the mammæ of the mothers with milk immediately after parturition, nature has given to animals the two-fold advantage of a nouriſhment neceſſary to their young, and an evacuation uſeful to the mothers. The latter, after the abundance of the fluids which have long diſtended their uterine ſyſtems, find in the evacuation of the milk a diſcharge for thoſe redundant fluids, whilſt their young derive from it a ſupport appropriated to their weakneſs, at firſt laxative, but afterwards becoming more and more nutritious, eaſy to be aſſimilated into their own ſubſtance, and containing, by an admirable inſtitution of Providence, the ſolidifiable matter of their bones in a proportion correſponding with the rapid augmentation which theſe organs muſt experience during the firſt period of life. In this two-fold point of view, it is evident, that it is equally neceſſary to the mothers, after delivery, to evacuate this ſuper-abundance of fluids, and to the young to nouriſh themſelves with it: and that while the former cannot without danger renounce the ſuckling of their young, theſe likewiſe cannot be deprived of this aliment without inconvenience. Accordingly, ſevere, painful and frequently fatal diſeaſes are the juſt puniſhment of mothers who renounce this duty, whilſt a permanent weakneſs and languor throughout the whole of their lives, impend over the young animals that are deprived of this food.

80. Man muſt ſoon, and almoſt in the firſt ages of the world, have been led by obſervation to employ as food the milk of the animals which he has been able to tame and render ſubſervient to his wants. Accordingly, the different alimentary preparations of milk are traced back to the moſt remote ages of antiquity. The abundance of milk laſts only for a ſeaſon, or at leaſt it is ſoon too much diminiſhed to be ſufficient for the ſupply of the wants of man; it was therefore neceſſary that means ſhould be diſcovered for preparing it in ſuch a manner that the ſuperfluity of one period of the year might be kept to ſupply the deficiency of the others. Hence the different kinds of cheeſes. The natural alterations which milk undergoes, being early obſerved, have alſo given riſe to the great multitude of various aliments that are prepared with this liquid, eſpecially cream, butter, curd, butter milk, ſour whey, &c. The Tartars have long poſſeſſed the art of preparing intoxicating liquors with milk. Its employment as a ſeaſoner, its mixture and combination with fruits, honey, ſugar, the different infuſions and decoctions, the vegetable perfumes which add more or leſs agreeable taſtes and ſmells to the mildneſs and unctuoſity of milk, were not contrived till long after the diſcovery of the products obtained from this liquid. Art has ſo much multiplied this preparation, that it would be uſeleſs to attempt their enumeration;

meration; beſides which they vary in the different countries. Modern chemiſtry has added to the ancient economical uſes of milk, that of converting it into vinegar, which in certain provinces may be an advantageous ſubſtitute for the acid furniſhed by wine, cyder, beer and the four fruits.

81. There are few medicinal ſubſtances that have been applied to ſuch a multitude of uſes by the phyſicians as milk. As a mild, relaxing, emollient, cooling ſubſtance, it is adapted to a great number of maladies. There are ſome even upon which it ſeems to exert a ſpecific action, as the attacks of the gout, the rheumatiſm, obſtinate herpetic erruptions, incipent depravation of the lungs, ulcerated affections of the urinary paſſages, &c. To this general and common action of all kinds of milk upon the animal economy, experience has ſhown that we may add the particular action of each ſpecies of milk: that the milk of the aſs is the lighteſt and the moſt eaſily digeſted; that of the goat much heavier and adapted for ſtrong and vigorous ſtomachs, and for thoſe caſes in which the body is to be nouriſhed and invigorated; that the human milk, the ſweeteſt and moſt ſaccharine, in which the caſeous part is the moſt abundant, is on the contrary well adapted to weak ſtomachs and difficulty of digeſtion. Accordingly, it is with the intention of fulfiling theſe different indications that the phyſicians preſcribe one or the other of the four

kinds of milk, the human milk, goats' milk, aſſes' milk and cows' milk. They have alſo thought fit to divide the milk and to dilute it with water, to prepare from it the whey or ſerum, and to adminiſter it either ſweet and clairified, or ſoured, to combine the different kinds of milk with different remedies, to ſoften or moderate their effects by this addition, or to favour the intromiſſion of this liquid into the humours by giving it a little more activity, by correcting its inſipidity, its weight upon the ſtomach, its occaſional aſtringent effect, or on the contrary its relaxing operation. It is neceſſary that the phyſician ſhould be provided with an accurate knowledge of chemiſtry, in order to be able to preſcribe theſe mixtures and theſe combinations of milk with different medicinal ſubſtances without deſtroying the properties of the latter: thus he ought to know that lime water precipitates calcareous phoſphate from it by paſſing itſelf into this ſtate, that many metallic ſalts are decompoſed in it, and that matters ſuſceptible of aceſcence coagulate it. Laſtly, the adminiſtration of milk in medicine has been carried ſo far, as to impregnate it with ſome medicinal properties by treating in different ways the animals that furniſh it, or the nurſe herſelf who ſuckles the infant.

82. The multiplied reſources which the milk of animals affords under a thouſand diverſified forms, leave but little room for the

uſe of theſe valuable liquids to arts not belonging to the nouriſhment of the body. However, though it be not much employed in the arts, it is however not without utility in this point of view. Milk that has become ſour and turbid is frequently employed in the manufactories where fine cloths are dreſſed, in order to give them that beautiful white which is not improperly called milk-white. It is even believed in theſe manufactories that no other ſubſtance can be ſubſtituted for this lactic acid, though able chemiſts have maintained that the ſulphuric acid diluted with water produces the ſame effect. Barrels filled with ſour whey are ſent from the rich mountains of Switzerland into France, for the purpoſe of being employed in this proceſs of bleaching. I have elſewhere obſerved, that the caſeous matter, kneaded freſh with lime, forms a tenacious paſte, ſuſceptible of hardening, which is employed for cementing broken porcelain together. Rancid butter is rendered ſubſervient to a number of uſes by the induſtry of the chemical arts: it is manufactured into ſoap, and other compounds.

END OF THE NINTH VOLUME.

W. FLINT, Printer, Old Bailey.

better
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~~The changing and shadows freely floated~~
~~[illegible]~~ in

First appeared in form array.

First appeared in form array.
The changing and ~~[illegible]~~ shadows in the blue
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~~[illegible]~~
~~The half~~
~~[illegible]~~

Is poor church music, which in lofty [illegible]

Along the sheets with ~~[illegible]~~ mind t'wine
Their lines of our music laws.

& better
Just this bald unadorned letter.
And the Lord Vane of war.
of walls [illegible] pretty
a walking cot a fit to
it was like time [illegible]!

Led by a dean

~~Oration on a Moonlit~~ Eve

Lux on Art.

fierce
A battle one moonlight night
upon our sloping eaves.
Two fiercely waged feline fights

~~thats~~
To screen the Tom cats bold —
The lady shrill refrain
~~Forward~~ if

[illegible] [illegible] a dauntless [illegible] shall
The ebony and [illegible] appear
[illegible] the [illegible] well
fall upon his bo

A fierce and bloody fight
tiles
was fought upon our ~~walls~~
and fiercely raged the feline fight
~~with~~
With dire unearthly squalls

3
notes
~~[illegible]~~
To hear the Tom Mellow bass
The lady's shrill refrain
~~[illegible]~~
~~[illegible]~~
~~shrill music from~~
~~to pour in our~~ ears
Vanquished hero mournful sigh
Of mingled rage & pain

Kitty
~~Tim~~
3
First the bould warrior tabby.

~~[illegible]~~
Led the proud Calypsi band—
~~[illegible]~~
~~[illegible]~~ marrtabby —
~~[illegible]~~
~~Her coat [illegible] feather fitly.~~
A well fed [illegible] by the Mean [illegible]—

squeals—
chuckled ~~Champion~~
& then sighed out The [illegible] ~~Chieftain~~
asked at his throat [illegible] family [illegible]—
[illegible] [illegible] the [illegible] a [illegible]
his [illegible] [illegible] [illegible] be [illegible]